PB-215 403

BLACK-WATER IMPOUNDMENT INVESTIGATIONS

Richard W. Warner, et al

Federal Water Pollution Control Administration
Cincinnati, Ohio

1969

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 215 403

BLACK-WATER IMPOUNDMENT INVESTIGATIONS

by

Richard W. Warner, R. Kent Ballentine,

and Lowell E. Keup

Technical Advisory and Investigations Branch
Division of Technical Support
Federal Water Pollution Control Administration
United States Department of the Interior
5555 Ridge Avenue
Cincinnati, Ohio 45213

1969

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

FOREWORD

On April 24, 1968, a meeting was held at the Wilmington District Corps of Engineers Office to discuss the need for a multiple-level outlet structure and the adequacy of water quality in the proposed Kornegay Reservoir for water supply and recreational uses. At the conclusion of the meeting the FWPCA Middle Atlantic Region was requested to develop a study proposal for investigation of the effects of organic sediments on water quality and the need for removal of these materials during construction. By letter dated May 20, 1968, the Corps of Engineers requested a field reconnaissance survey of the proposed Reservoir site and nearby water supply impoundments at Wilson, North Carolina. A preliminary field survey was conducted on June 5, 1968, and the Corps of Engineers requested that a cooperative field investigation be made to determine the expected water quality in the proposed Kornegay Reservoir and the effects of bottom organics on the impounded water.

This study was carried out in accordance with the provisions of Section 5(a) of the Water Pollution Control Act, as amended, and Executive Order 11288.

TABLE OF CONTENTS

	Page
Foreword.	1
Figure Index	4
Table Index	5
Summary	8
Conclusions	11
Recommendations	13
Introduction	14
Field Studies	18
Morphometry	18
Chemistry	19
Color and Lignin	19
Light Penetration	21
Nutrients and Water Quality	21
Mineral Quality	26
Stratification	27
Bottom Oxygen Demand	32
Biological Studies	33
Phytoplankton	33
Periphyton	35
Primary Production	38
Benthos	40

Reproduced from best available copy.

TABLE OF CONTENTS (Cont.)

	Page
Soil Leaching Studies	41
Results	45
Lignin (Color)	45
Iron	47
Manganese	49
Phosphorus	51
Nitrogen	53
Acknowledgements	56
Appendix	58
Methods	59
References	69
Tabulated Data	71

FIGURE INDEX

Figure		Page
A	Reservoir map of proposed Kornegay project.	96
B	Hydrographic map of Lake Wilson, N. C.	97
C	Hydrographic map of Wiggins Mill Pond, N. C.	98
1	Schematic diagram of sampling stations.	16
2	Lake sampling stations.	17
3	Stratification, 7 August 1968.	29
4	Lake Wilson, temperature and dissolved oxygen profiles.	30
5	Wiggins Mill Pond, temperature and dissolved oxygen profiles.	31
6	Wiggins Mill Pond periphyton.	36
7	Lake Wilson periphyton.	36
8	Wiggins Mill Pond chlorophyll a.	37
9	Lake Wilson chlorophyll a.	37
10	Wiggins Mill Pond gross photosynthesis.	39
11	Lake Wilson gross photosynthesis.	39
12	Scatter diagram; leaching studies, color vs. lignin..	43
13	Lignin leached from soils.	46
14	Iron leached from soils.	48
15	Manganese leached from soils.	50
16	Total phosphorus leached from soils.	52
17	Total nitrogen leached from soils.	54

Reproduced from best available copy.

TABLE INDEX

Table		Page
1	Chemical Data - N. E. Cape Fear River at Duplin Co. Road 1502 (Station CF-1).	71
2	Chemical Data - Poley Branch of N. E. Cape Fear River at N. C. Highway 111 (Station PB-2). . . .	72
3	Chemical Data - N. E. Cape Fear River at Duplin Co. Road 1506 (Station CF-3).	73
4	Chemical Data - N. E. Cape Fear River at Duplin Co. Road 1519 (Station CF-4).	74
5	Chemical Data - N. E. Cape Fear River at N. C. Highway 11 (near Kornegay Dam site) (Station CF-5).	75
6	Chemical Data - Contentnea Ck. at Wilson Co. Road 1154 (Station CC-6).	76
7	Chemical Data - Contentnea Ck. at Wilson Co. Road 1162 (Station CC-7).	77
8	Chemical Data - Wiggins Mill Pond surface outlet (Station CC-8).	78
9	Chemical Data - Toisnot Ck. at N. C. Highway 58 near Silver Lake (Station T-9).	79
10	Chemical Data - Lake Wilson surface outlet (Station T-10)..	80

TABLE INDEX (Cont.)

Table		Page
11	Chemical Data - Toisnot Ck. at Wilson Co. Road 1327 (Station T-11).	81
12	Chemical Data - Toisnot Ck. immediately downstream from Lake Toisnot (Station T-12). . . .	82
13	Chemical Data, surface vs. bottom, Wiggins Mill Pond and Lake Wilson	83
14	Average standing crop of phytoplankton, Wiggins Mill Pond and Lake Wilson, 29 July - 10 August, 1968.	84
15	Standing crop of periphyton, Wiggins Mill Pond and Lake Wilson, 26 July - 7 August, 1968	85
16	Benthic invertebrates, Wiggins Mill Pond and Lake Wilson, August, 1968.	86
17	Chemical constituents in waters used in leaching studies.	87
18	Chemical constituents in waters leaching leaf litter . . .	88
19	Chemical constituents in waters leaching muck	89
20	Chemical constituents in waters leaching loam	90
21	Chemical constituents in waters leaching sand	91

Reproduced from best available copy.

TABLE INDEX (Cont.)

Table		Page
22	Weather information, Wilson W2 Station, Wilson, N. C. . . .	92
23	Bottom oxygen uptake rates, July-August, 1968	93
24	Waste inventory, Mt. Olive, N. C.	94
25	Chemical qualities of ground water supplies	95

SUMMARY

In late July and early August, 1968, a study was conducted to predict the quality of Northeast Cape Fear River waters to be impounded in Kornegay Reservoir, Duplin County, North Carolina. This study was requested by the Corps of Engineers because the highly colored river water will inundate rich organic soils and vegetation that may leach undesirable materials and affect water quality adversely for fish propagation, wildlife, flow augmentation, water supply, and recreation. To assess the magnitude of the problem and to predict the effects of removal of vegetation and soils from the reservoir site, chemical and biological conditions of the Northeast Cape Fear River were compared with those of two small reservoirs with highly colored influents near Wilson, N. C. Laboratory tests were conducted to assess the quality and quantity of materials that could be leached from several soils collected at the reservoir site.

Wiggins Mill Pond, one of the reservoirs studied, occupies an undisturbed lake bed. Surface waters here contained 9.5 mg/l lignin, 42 percent greater than the concentration in inflowing Contentnea Creek. Total nitrogen averaged 0.74 mg/l; 0.69 mg/l was organic nitrogen. Total phosphorus concentrations averaged 0.10 mg/l, iron averaged 1.9 mg/l and manganese averaged 0.08 mg/l. Waters collected near the lake bottom were

anaerobic and contained significantly greater concentrations of lignin (19.6 mg/l), ammonia nitrogen (0.19 mg/l), total phosphorus (0.23 mg/l), iron (10.2 mg/l), and manganese (0.85 mg/l) than did surface waters. The bottom oxygen demand rate was 1.2 grams O_2/M^2/day. Sunlight penetrated to 4.2 feet; however, respiration exceeded gross primary production in all but the upper 1 foot of water. Phytoplankton numbered 7,300/ml (4.7 ppm) in Wiggins Mill Pond and 760/ml in inflowing Contentnea Creek. Benthic invertebrates numbered only 40-390/ft^2.

Lake Wilson, the other reservoir studied, occupies a lake bed that has been cleared of vegetation and organic soil. Surface waters contained 13.1 mg/l lignin, 14 percent more than in inflowing Toisnot Creek. Total nitrogen averaged 0.82 mg/l; 0.77 mg/l of this was as organic compounds. Lake Wilson surface waters contained 0.06 mg/l total phosphorus, 1.5 mg/l iron, and 0.08 mg/l manganese. Waters collected near the lake bottom, although anaerobic, contained concentrations of lignin (16.9 mg/l), total nitrogen (0.96 mg/l), organic nitrogen (0.88 mg/l), ammonia nitrogen (0.08 mg/l), total phosphorus (0.08 mg/l), iron (3.8 mg/l), and manganese (0.22 mg/l) that were not greatly increased over those of surface waters. The oxygen demand rate of lake bed materials was 0.9 grams O_2/M^2/day. Sunlight penetrated to 3.5 feet; however, respiration exceeded gross

primary production at all levels. Phytoplankton numbered 18,000/ml (8.9 ppm) in Lake Wilson and 5,900/ml in inflowing Toisnot Creek. Benthic invertebrates numbered only 36-310 /ft^2.

The Northeast Cape Fear River to be impounded in Kornegay Reservoir contained high concentrations of lignin (13.6 mg/l), total nitrogen (2.7 mg/l), ammonia nitrogen (0.7 mg/l), nitrate nitrogen (1.4 mg/l), and manganese (0.7 mg/l). Laboratory studies indicated that this water can leach additional quantities of lignin, iron, manganese, and total phosphorus from leaf litter from the reservoir site. Iron and manganese were leached at a greater rate under anaerobic conditions. Manganese concentrations increased slightly in tests with muck. Leaching tests involving loam and sand indicated no significant increases in the concentrations of water quality constituents.

CONCLUSIONS

1. Northeast Cape Fear River water to be impounded in Kornegay Reservoir is highly colored. This water will remain highly colored after impoundment; lake bed preparation would retard the leaching of additional color-producing materials from the soil.
2. Although the Northeast Cape Fear River carries sufficient nutrients for massive algal blooms, limited light penetration is expected to restrict the numbers and volumes of phytoplankton in Kornegay Reservoir to moderate levels comparable to those of Lake Wilson and Wiggins Mill Pond.
3. Sufficient light for photosynthesis is expected to be limited to a depth of 4 to 5 feet in the proposed Kornegay Reservoir. This will limit the contribution of dissolved oxygen by phytoplankton. Algal respiration and decomposition of organic materials will probably require more dissolved oxygen than that produced by the algae.
4. If thermal and chemical stratification approximates the depth of photosynthesis in the summer, anaerobic water will occupy a large volume of Kornegay Reservoir. If the thermocline is deeper, a greater volume of the reservoir will be aerobic.
5. Surface waters of the reservoir will be aerobic. Most of the nitrogen in the surface waters will be in the form of organic

Reproduced from best available copy.

compounds or biological growths. Phosphorus, iron, and manganese concentrations will approximate those of the Northeast Cape Fear River.

6. If rich organic soils are removed from or plowed into the reservoir bottom, the concentrations of ammonia nitrogen, iron, and manganese in deep, hypolimnetic waters are expected to approximate those in surface waters. These recommended site-preparation procedures can enhance the use of Kornegay Reservoir for all desired purposes, including flood control, flow augmentation, water supply, recreation, fisheries, and wildlife.
7. If rich organic soils are not removed or plowed under, the anaerobic waters of the Kornegay Reservoir hypolimnion are expected to contain concentrations of ammonia nitrogen, iron, and manganese that will exceed permissible levels for raw water recommended in Water Quality Criteria during summer. Difficulty may be experienced in the treatment of such water for domestic use.
8. Improved wastewater treatment at Mt. Olive, North Carolina, would improve water quality in the proposed Kornegay Reservoir.

RECOMMENDATIONS

1. That organic rich materials, especially leaf litter, be removed or plowed into the soil to prevent leaching of excessive iron, manganese, and lignin to the water.
2. That provision be made for water supply intakes at the surface and for bi-level penstock releases from near the surface and near the bottom of the reservoir to permit selection of good quality waters during critical periods and the wasting of waters with undesirable materials during non-critical periods.
3. That Kornegay Reservoir be initially filled to the conservation pool level and then drained to flush undesirable materials downstream from the disturbed and recently inundated reservoir bed.
4. That all wastewaters discharged at Mt. Olive, N. C., receive secondary treatment, and that existing and proposed secondary waste treatment facilities be maintained at an operating efficiency of at least 85 percent waste removal.

INTRODUCTION

The U. S. Army Corps of Engineers proposes to impound the Northeast Cape Fear River near the community of Kornegay, Duplin County, North Carolina. Kornegay Reservoir will be designed for multiple uses including flood control, water supply, flow augmentation for downstream water quality improvement, recreation, fisheries, and wildlife. The river water is highly colored. Kornegay Reservoir will inundate an area of rich organic soils that may leach additional undesirable materials to the water, adversely affecting water quality for proposed uses. The Corps of Engineers requested the Middle Atlantic Region of the Federal Water Pollution Control Administration to assess the magnitude of the problem and to recommend methods to alleviate or reduce the addition of undesirable materials to the impounded waters. In turn, the Region requested that this survey be conducted by the Technical Advisory and Investigations Branch, FWPCA Headquarters, Cincinnati, Ohio.

To predict the effects of site preparation on Kornegay Reservoir, limnological investigations of two water supply reservoirs, Lake Wilson and Wiggins Mill Pond, near Wilson, North Carolina, were conducted in

Reproduced from best available copy.

late July and early August 1968. Both of these reservoirs receive highly colored waters that are chemically similar to the water of the Northeast Cape Fear River. Lake Wilson, an impoundment on Toisnot Creek, occupies a lake bed that was cleared of organic soil. Wiggins Mill Pond, an impoundment on Contentnea Creek, occupies an undisturbed lake bed, and contains many stumps, trees, and other vegetation. Wiggins Mill Pond was impounded in 1918 and Lake Wilson was impounded in 1960. Chemical and biological characteristics of these impoundments and their influents were compared with present characteristics of the Northeast Cape Fear River, located in similar environs fifty miles south of the reservoirs studied. Schematic diagrams of station locations and designations on the Northeast Cape Fear River and the reservoirs and inflowing streams are shown in Figures 1 and 2.

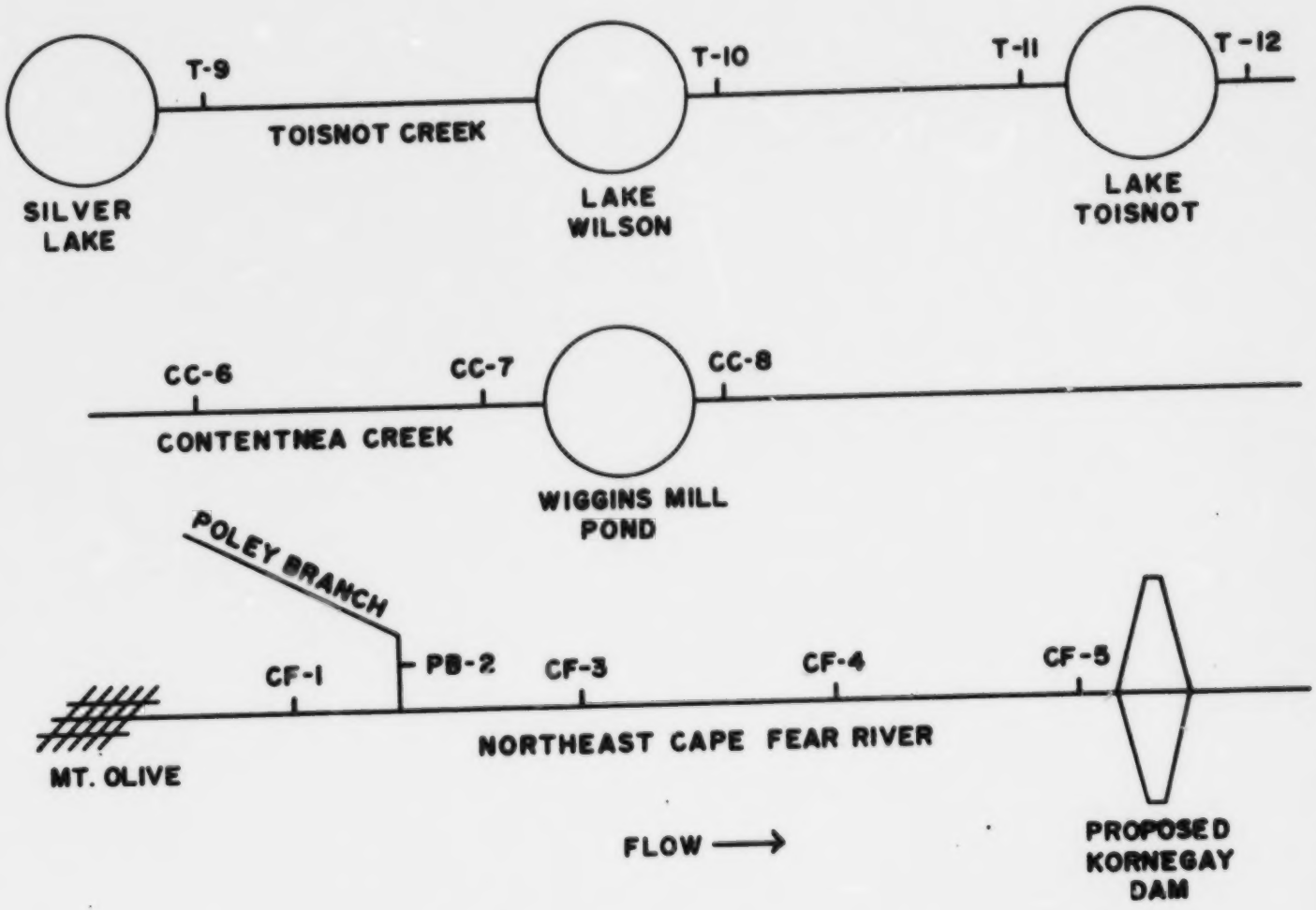


FIGURE 1. SCHEMATIC DIAGRAM OF SAMPLING STATIONS.

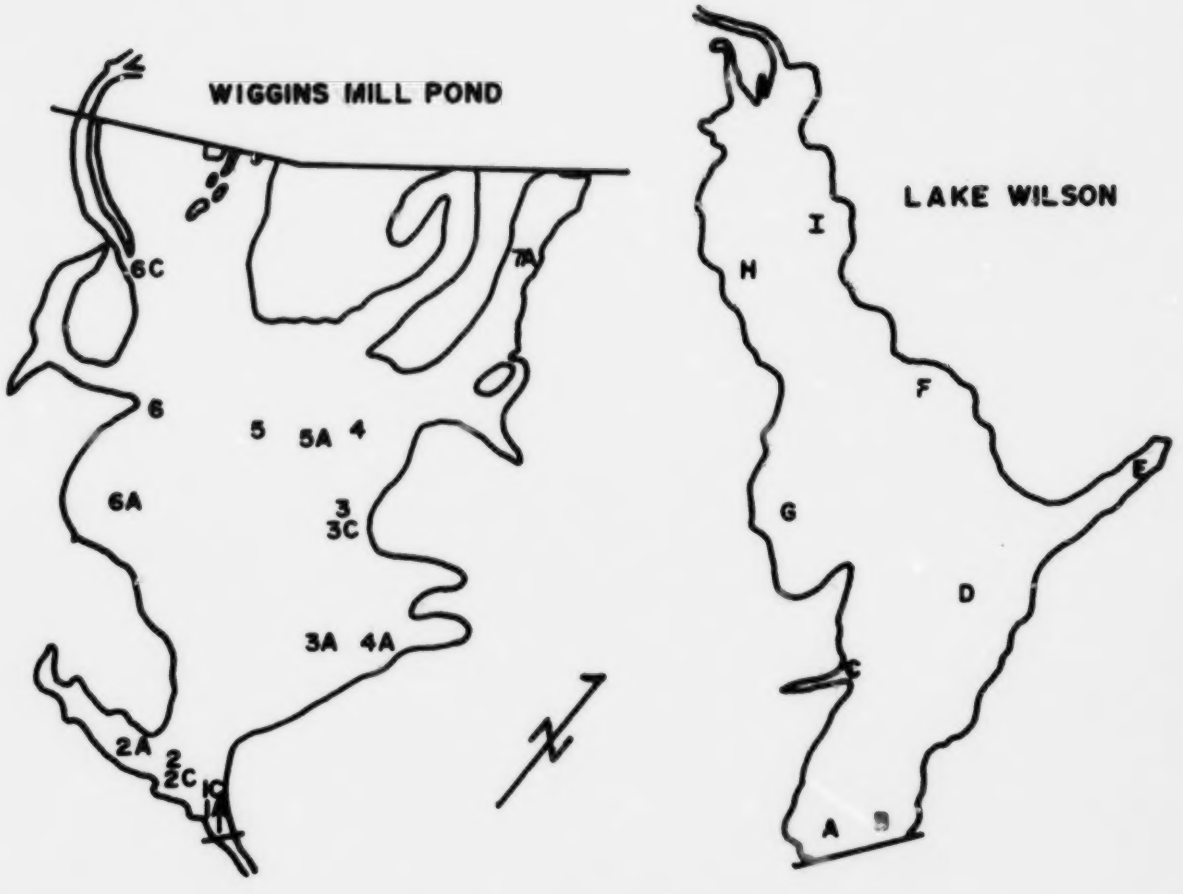


FIGURE 2. LAKE SAMPLING STATIONS (maps not to scale).

FIELD STUDIES

MORPHOMETRY

Maps of the proposed Kornegay Reservoir, Lake Wilson, and Wiggins Mill Pond are inserted in the appendix of this report. The pertinent physical data for these lakes are summarized as follows:

	Lake Wilson	Wiggins Mill Pond	Kornegay Reservoir Flood Pool	Kornegay Reservoir Conservation Pool
Length (feet)	4,300	8,150	60,000	48,000
Mean Breadth (feet)	888	1,398	4,860	4,200
Maximum Depth (feet)	9	14	33	26
Mean Depth (feet)	4.1	4.6	11.9	10.2
Area (acres)	88	374	6,700	4,700
Volume (acre feet)	364	1,611	80,000	48,000

Wiggins Mill Pond was impounded without clearing of trees or vegetation. The Lake Wilson site was cleared and much of the organic rich surface soil was removed from over 90 percent of the lake bed area during the process of deepening the basin to increase the reservoir capacity.

CHEMISTRY

Color and Lignin

The waters flowing into Wiggins Mill Pond (Contentnea Ck.) and Lake Wilson (Toisnot Ck.) and in the Northeast Cape Fear River were chemically similar (Tables 1, 3, 4, 5, 6, 7, 9). Each was soft and weakly buffered, containing low concentrations of alkalinity and acidity and each was highly colored. Pertinent chemical data are summarized as follows:

	Contentnea Creek (CC-7)	Toisnot Creek (T-9)	Northeast Cape Fear River (CF-1)
Acidity (mg/l $CaCO_3$)	4	5	6
Alkalinity (mg/l $CaCO_3$)	17	9	16
pH (units)	6.9	6.4	6.5
Color (units)	114	126	141
Lignin[1] (mg/l)	6.7	11.5	13.6

High color levels may cause many problems in impounded waters; sunlight penetration is restricted to very shallow depths and algal photosynthesis occurs only in the uppermost water. Respiration of

[1] Standard Methods (1965). Includes other "lignin-like" substances such as tannin.

algae and other organisms and organic decomposition produce an oxygen deficit in deeper waters, especially during summer months when thermal stratification prevents mixing of surface and bottom waters. Anaerobic waters are uninhabitable to fish and other aquatic animals and may cause difficulty in water treatment because of increased quantities of iron and manganese, nitrogenous materials reduced to ammonia, noxious tastes and odors, and increased color.

Surface waters of Lake Wilson contained 13.1 mg/l lignin, 14 percent more than in inflowing Toisnot Creek (Tables 9 and 10). Waters collected near the lake bottom contained quantities of lignin (16.9 mg/l) that were not greatly increased over those of surface waters (Table 13). Lignin concentrations in Wiggins Mill Pond surface waters averaged 9.5 mg/l, 42 percent higher than those of inflowing Contentnea Creek (Tables 7 and 8); waters near the lake bed contained significantly more lignin (19.6 mg/l) than did surface waters (Table 13). Significant quantities of color-producing lignin are being leached from the undistrubed bed of Wiggins Mill Pond. Studies by Raabe (1968) indicate that lignin decomposes on storage in water; thus, the high concentrations of lignin detected in Wiggins Mill Pond deep waters are not considered to be derived

from high-flow spring runoff. Lignin concentrations in the Northeast Cape Fear River averaged somewhat higher (13.6 mg/l) than in either Toisnot Creek or Contentnea Creek and are expected to be at least as high when impounded in Kornegay Reservoir (**see Soil Leaching Studies section, p. 41**).

Light Penetration

Because of the high degrees of color in the reservoirs, incident sunlight penetration was restricted. In Lake Wilson, light penetrated to approximately 3.5 feet (1 percent insolation level), giving Secchi disc readings of about 1.5 feet. Sunlight penetrated approximately 4.2 feet in Wiggins Mill Pond (1 percent insolation level), and a Secchi disc was visible to about the 2 feet depth. The Northeast Cape Fear River also contained high concentrations of color-producing materials (Tables 1, 3, 4, 5), and is expected to exhibit similar conditions of poor light penetration when impounded.

Nutrients and Water Quality

Analyses of Contentnea Creek and Wiggins Mill Pond waters revealed that storage in the reservoir had little effect on the concentrations of surface water nutrient components; an exception to this was the conversion of most inorganic nitrate to organic nitrogen

(Tables 7 and 8). During the period of study, nitrate concentrations decreased from 0.3 mg/l N in Contentnea Creek to less than 0.1 mg/l N in the surface waters of Wiggins Mill Pond. Most of the nitrogen in the surface waters of Wiggins Mill Pond was in the form of organic compounds which averaged 56 percent higher than the 0.39 mg/l N recorded for Contentnea Creek, and resulted from uptake by biological growths. In both the reservoir and Contentnea Creek, ammonia concentrations averaged only 0.05 mg/l N. High total phosphorus (avg. 0.12 mg/l P) and iron (avg. 2.2 mg/l) levels in Contentnea Creek were not substantially reduced in the epilimnion of Wiggins Mill Pond. Manganese levels were less than 0.08 mg/l in both water masses.

Nutrient concentrations in the epilimnion of Lake Wilson and in its influent (Toisnot Creek) were similar to those found in Wiggins Mill Pond. Eighty-nine percent of the nitrogen in Toisnot Creek was as organic compounds (avg. 0.68 mg/l N), and remained in this form in Lake Wilson surface waters (Tables 9 and 10). Both nitrate (< 0.1 mg/l) and ammonia nitrogen (0.06 mg/l) were measured at low average concentrations in Lake Wilson surface waters. Total phosphorus concentrations averaging 0.07 mg/l in Toisnot Creek

decreased slightly to 0.06 mg/l P in Lake Wilson. Iron concentrations averaging 1.5 mg/l in Toisnot Creek remained at the same high level on storage in Lake Wilson. Manganese concentrations in the reservoir surface water (0.08 mg/l) were not significantly different from those in the influent (0.13 mg/l).

In the deeper waters (hypolimnion) of Wiggins Mill Pond, chemical changes occurred that could be important in water treatment. Ammonia nitrogen concentrations averaged over three times higher (0.19 mg/l) in the anaerobic hypolimnion than in the aerobic epilimnion; average values for phosphorus (0.23 mg/l), iron (10.2 mg/l), and manganese (0.85 mg/l) were about double, five times, and eight times higher, respectively, in the hypolimnion (Table 13). The average concentrations of iron and manganese in hypolimnetic waters would require additional chemical treatment and expense to be reduced to the acceptable combined concentration of 0.3 mg/l recommended for finished water in Drinking Water Standards (U. S. P. H. S., 1962). Without adequate treatment, noxious tastes and odors, discoloring of laundry goods, and pipeline fouling problems could be encountered. Waters collected near the bottom of Lake Wilson contained concentrations of ammonia nitrogen (0.08 mg/l), phosphorus (0.08 mg/l), iron (3.8 mg/l), and manganese (0.22 mg/l) that were not greatly increased over those of

surface waters. The City of Wilson, N. C., withdraws surface waters from both Lake Wilson and Wiggins Mill Pond and successfully and economically treats them for municipal use.

The waters to be impounded in Kornegay Reservoir are rich in nutrients. These chemicals, which stimulate the growth of planktonic algae, are derived in part from the soils of the drainage basin, but, to a large extent from sewage and food processing waters being discharged to the Northeast Cape Fear River near Mt. Olive, North Carolina. The Northeast Cape Fear River at upstream station CF-1 will be the major water source for Kornegay Reservoir and contained 3 times more nitrogen (2.7 mg/l) and 8 times more phosphorus (0.46 mg/l) than tributary Poley Branch which does not carry waste materials (Tables 1 and 2). In the free-flowing river, 0.7 mg/l of the total nitrogen was ammonia, and 1.4 mg/l was nitrate. If these waters were incorporated in an anaerobic hypolimnion, the nitrate ions would be subjected to denitrification and thereby be reduced to ammonia. This process may produce a 200 percent increase in ammonia concentration, which would require an increased amount of chlorine for disinfection. Chlorine is an oxidizing agent; it requires 5.7 mg of chlorine to react with 1 mg of ammonia, before a free chlorine residual is present

to assure adequate bactericidal action. The net chlorine requirement for reaction with the present and potential ammonia concentration of 2 mg/l would be 10 - 14 mg/l, without regard to the excess of free chlorine required for disinfection. The cost of chlorinating anaerobic hypolimnetic waters would increase 200 percent above the cost of chlorinating aerobic epilimnetic waters. The already high levels of nitrogen (avg. 2.7 mg/l N) and phosphorus (avg. 0.46 mg/l) P) would be a source of nuisance algal blooms in clearer water; however, the high levels of color measured (avg. 141 color units at station CF-1) are expected to restrict the penetration of sunlight, thus serving as a counterbalance to limit the development of nuisance algae.

Impoundment of the Northeast Cape Fear River will create additional problems for water treatment. The already high average concentration of 1.5 mg/l iron is expected to increase in the anaerobic waters of the hypolimnion. Manganese concentrations averaged about the same (0.07 mg/l) as in Lake Wilson and Wiggins Mill Pond, but, are expected to increase in the hypolimnion of Kornegay Reservoir. Anaerobic water withdrawn from the hypolimnion of this reservoir for domestic consumption will require extensive treatment.

Mineral Quality

The 770 mg/l average total solids concentration in the Northeast Cape Fear River near Mt. Olive, North Carolina, was reduced to 370 mg/l near the proposed Kornegay Dam site by dilution with tributary inflows. Calculations[1] indicate that about 250,000 lb./day of total solids were added in the upper drainage basin over what would occur normally from drainage. Two major sources of total solids were the treated sewage discharges from the community of Mt. Olive, North Carolina, and the treated wastes from the Mt. Olive Pickle Company (Table 24).

The flow during the survey period approximated the 136 cfs average annual flow in the Northeast Cape Fear River at the Kornegay Dam site (based on drainage area adjustments of the Chinquapin, North Carolina, U.S.G.S. gage). If the discharge of solids occurring during the survey period was normal (The discharge of solids was higher than it should have been because the Mt. Olive secondary treatment plant was not operating properly.), the average total solids concentration in the Kornegay Reservoir would be about 370 mg/l[2]. This concentration

---

(1) The 55 mg/l total solids concentration in Poley Branch (PB-2) was considered normal for drainage in the upper Northeast Cape Fear Basin. Subtraction of this concentration from that observed at the four Northeast Cape Fear stations (CF 1,3,4, and 5) and converting the remaining concentration to pounds/day yields about 250,000 pounds/day.

(2) Total solids at station CF-5 consisted of 97 percent dissolved solids.

is greater than the 154 mg/l total dissolved solids found in ground waters in the same area (Table 25).

Iron concentrations averaged 0.38 mg/l in typical wells in the area (Table 25). This concentration is 42 percent of the 0.9 mg/l iron concentration which occurred in the Northeast Cape Fear River at station CF-5.

Northeast Cape Fear River water is of poorer mineral quality for water supplies than is ground water in the majority of wells in the watershed. But, with adequate treatment, this water could be made acceptable. The mineral quality of water in the proposed reservoir should not substantially affect water uses other than domestic supply when impounded. The depth at which water is withdrawn from the reservoir will influence that water quality and affect downstream uses.

Stratification

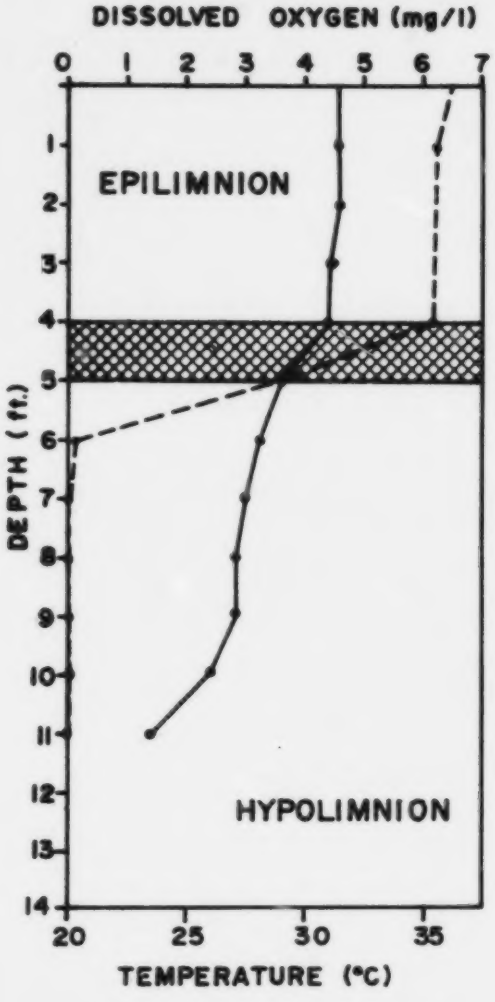
Wiggins Mill Pond and Lake Wilson are not thermally stratified permanently during the summer season. Thermal gradients from surface to bottom were exhibited by both reservoirs on July 29, 30 and 31, but, temperature differences were insufficient to prevent wind-induced mixing.

During the period from August 1 to 7, clear skies, light winds, and high air temperatures (Table 22) accelerated and intensified stratification. Solar radiation (light) penetrated the dark waters to depths of less than 5 feet and was absorbed as heat. High air temperatures restricted radiation of this absorbed heat back to the atmosphere, and winds were insufficient to induce mixing of warm surface waters with cooler deeper waters. As a product of these short-lived climatic conditions, temporary but distinct thermal stratification was established in both Wiggins Mill Pond and Lake Wilson (Figure 3).

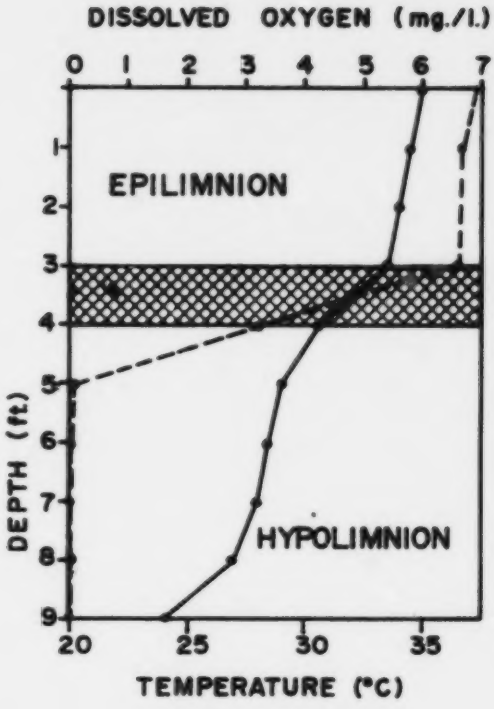
In Lake Wilson, water devoid of dissolved oxygen (D. O.) occurred at depths greater than 8 ft. on July 31 and at depths greater than 6.2 feet on August 7 (Figure 4). The 4 mg/l D. O. concentration contour occurred at the 6.2 foot depth on July 31, and at the 4.8 foot depth on August 7. Thus, water of low D. O. content occupied a greater portion of Lake Wilson's volume at the end of the survey period than at the beginning.

In Wiggins Mill Pond, anaerobic water was detected at the 9.5 foot depth on July 30, and at the 7.0 foot depth on August 7 (Figure 5). Here the 4 mg/l D. O. contour occurred at the 7 foot depth on July 30, and at the 5 foot depth on August 7.

Reproduced from best available copy.



WIGGINS MILL POND



LAKE WILSON

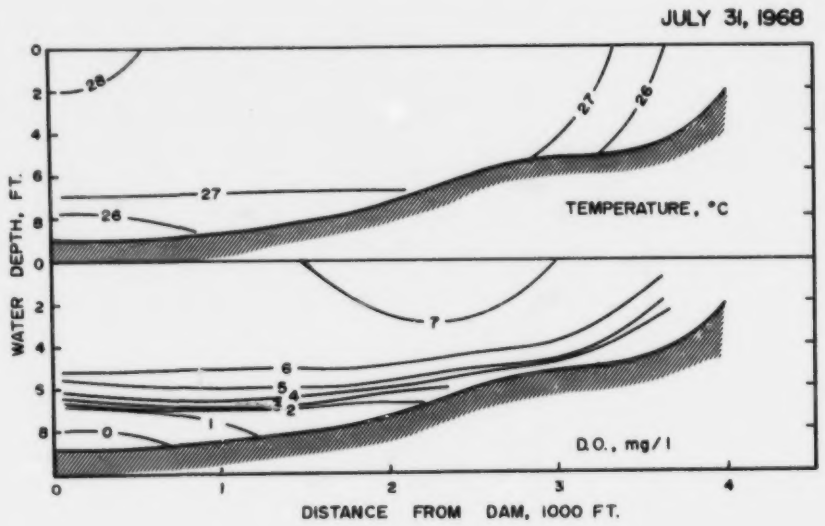
Stratification – 7 August, 1968

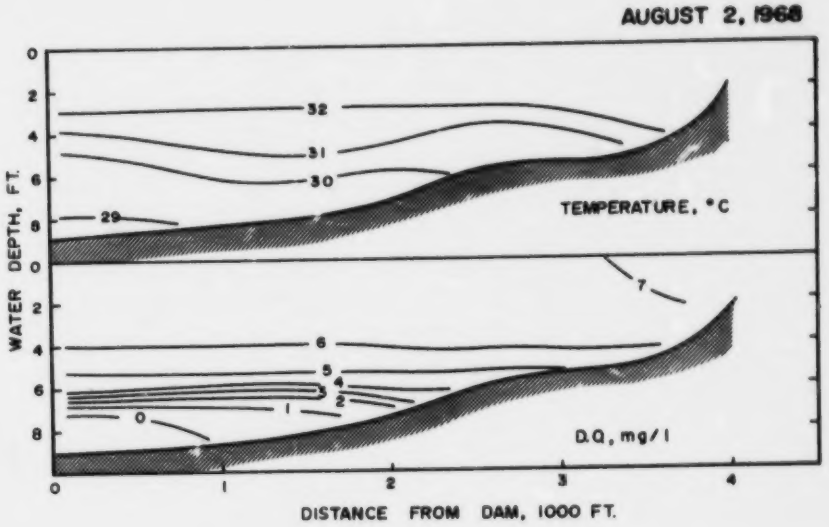
TEMPERATURE ——

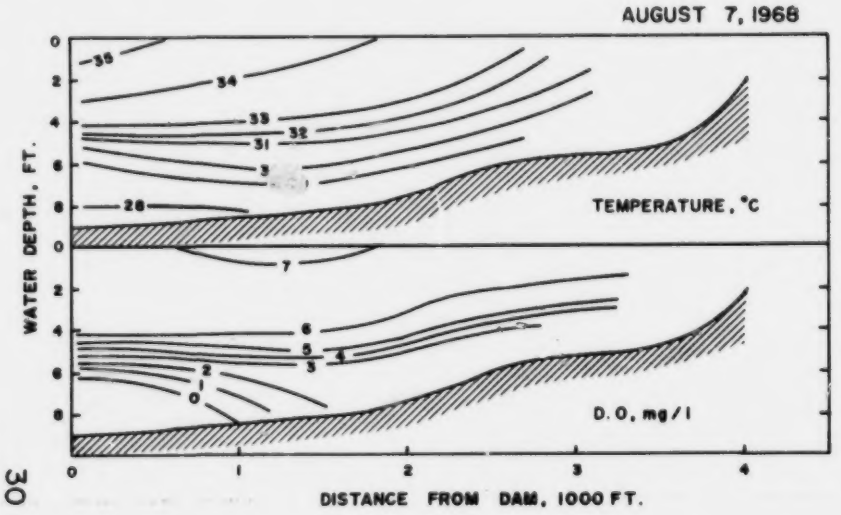
DISSOLVED OXYGEN ----

THERMOCLINE ▨

FIGURE 3.



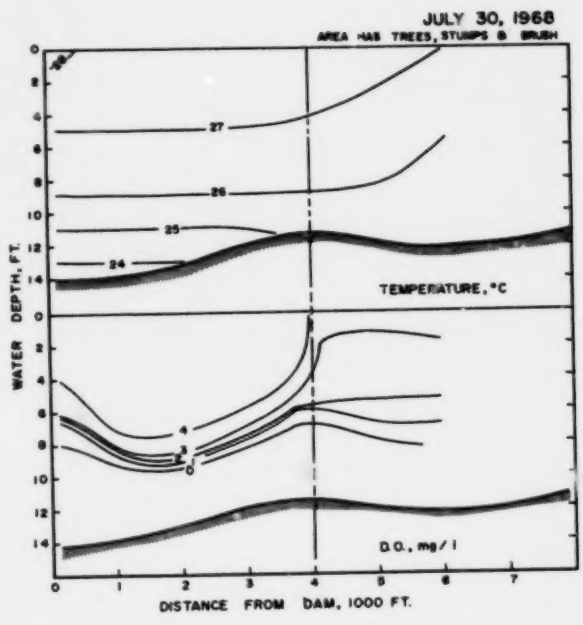


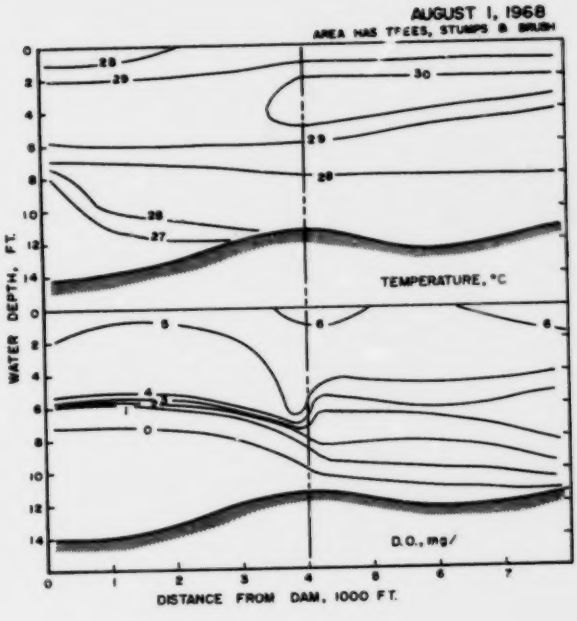


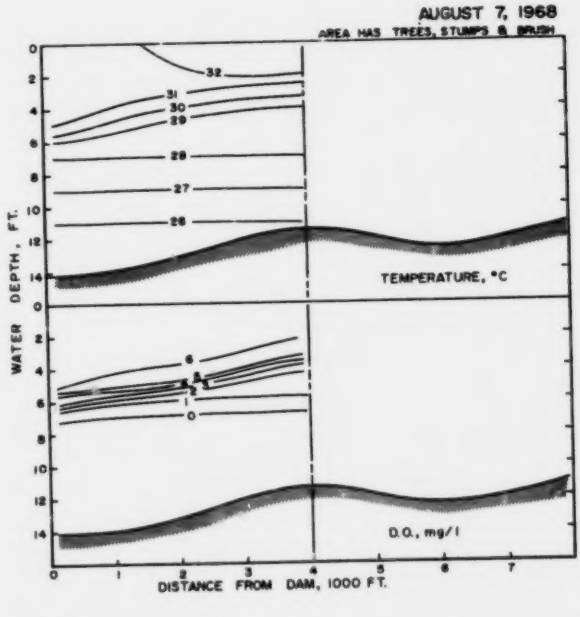
TEMPERATURE AND DISSOLVED OXYGEN PROFILES

LAKE WILSON, N.C.

FIGURE 4.







TEMPERATURE AND DISSOLVED OXYGEN PROFILES
WIGGINS MILL POND
N. C.
FIGURE 5.

Stratification in the proposed Kornegay Reservoir cannot be precisely predicted. This reservoir will have a maximum depth of 26 feet in its conservation pool, which is greater than the depth at which wind generally maintains mixing of warm epilimnetic waters. Seasonal thermal stratification may become established, with a well mixed epilimnion 15-20 feet in depth overlying colder anaerobic waters. In addition, distinct short-term stratification, such as observed in the reservoirs studied, may occur occasionally. The tendency for this to occur in Kornegay Reservoir will be less than in Wiggins Mill Pond and Lake Wilson because the proposed reservoir will have a greater surface area, and will be more subject to wind-induced mixing.

Bottom Oxygen Demand

Oxygen uptake by bottom materials is a significant factor in the dissolved oxygen balance of a thermally stratified lake. When a blackwater lake stratifies into two thermally distinct layers, the lower layer is deprived of two major oxygen sources: surface aeration and photosynthesis. The rate at which oxygen is used by organic decomposition and biotic respiration in this water layer and by decomposition of bottom materials determines the period of time this segment of water remains aerobic.

Bottom oxygen demand rates (Table 23) in Wiggins Mill Pond (1.2 grams O_2/meter^2/day) averaged 30 percent higher than those in Lake Wilson (0.9 grams O_2/meter^2/day). The greater utilization rate in Wiggins Mill Pond was caused principally by the lack of land clearing before lake filling. Over half of the area of the lake is studded with stumps, trees, and heavy brush; these increase the sedimentation of suspended materials by reducing wind-induced mixing and by reducing the amount of flushing during spring runoff. Growing plants also contribute significant amounts of organic materials (leaves, twigs, etc.) to the lake bottom.

Bottom oxygen demand rates in the proposed Kornegay Reservoir will be high for several years following filling of the reservoir. Following the initial stabilization period, and depending on site preparation, bottom oxygen demands will probably range from 0.7 gms O_2/meter^2/day if the lakebed is stripped of organic soil to 1.2 gms O_2/meter^2/day if the lake bed is not stripped.

Reproduced from best available copy.

BIOLOGICAL STUDIES

Because of restricted light penetration in the reservoirs studied, the contribution of dissolved oxygen from planktonic algae was limited

severely. Wiggins Mill Pond contained abundant nitrogen and phosphorus and supported phytoplankton populations with large numbers (avg. 7,300 algae/ml) of very small forms such as Glococystis and Chlorella-like coccoid green algae (Table 14). Lake Wilson supported even greater numbers of phytoplankton (avg. 18,000 algae/ml), the majority of these being the very small diatoms Asterionella and Synedra. The Northeast Cape Fear River supported phytoplankton populations (780 algae/ml) similar to those of Contentnea Creek (760 algae/ml), the influent to Wiggins Mill Pond. It is expected that the numbers of phytoplankton in Kornegay Reservoir will be similar to those in Wiggins Mill Pond. Toisnot Creek contained 5,000 algae/ml, but, this high number represents a contribution from Silver Lake upstream rather than a stream-inhabiting population.

Numbers of planktonic algae inhabiting both Lake Wilson and Wiggins Mill Pond were similar to those in eutrophic Lake Sebasticook, Maine, during much of the year (Mackenthun, et al., 1968). However, the volumes of algae inhabiting the North Carolina reservoirs were extremely low in comparison to those of the eutrophic lake in Maine. Lake Sebasticook was inhabited by large colonial planktonic forms that occupied a volume of

Reproduced from best available copy.

560 ppm during the July-August period, while the highest volume of algae encountered (in Lake Wilson) during this study was 29 ppm. Phytoplankton inhabiting the North Carolina reservoirs were small forms; Wiggins Mill Pond contained only 4.7 ppm of algal cells and Lake Wilson contained only 8.9 ppm (Table 14). It is expected that, although the Northeast Cape Fear River carries sufficient nutrient concentrations for massive algal blooms, restricted light penetration will confine the quantities and volumes of phytoplankton in Kornegay Reservoir to levels comparable to Lake Wilson and Wiggins Mill Pond.

Limited light penetration influenced the growth patterns of periphyton (attached algae) in both reservoirs (Table 15). In both reservoirs, periphyton growths occurred down to about the 1 percent level of insolation (ca. 4 feet). Wiggins Mill Pond supported a maximum periphyton population of nearly 400,000 algae/in^2 at the 3' level; Lake Wilson had a periphyton maximum of 175,000/in^2 at the 2' level (Figs. 6 and 7). Periphyton communities were numerically dominated by pennate diatoms (mostly Asterionella sp. and Synedra sp.). Chlorophyll a profiles (Figures 8 and 9 and Table 15) were similar in pattern to the numerical distribution of periphyton.

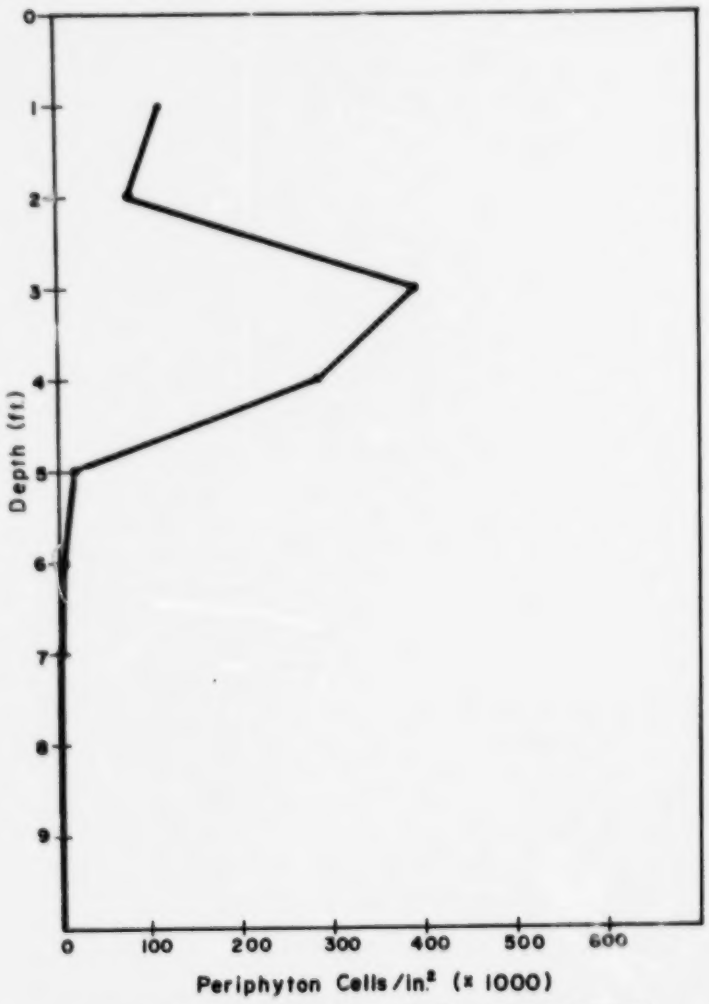


FIGURE 6. WIGGINS MILL POND PERIPHYTON.

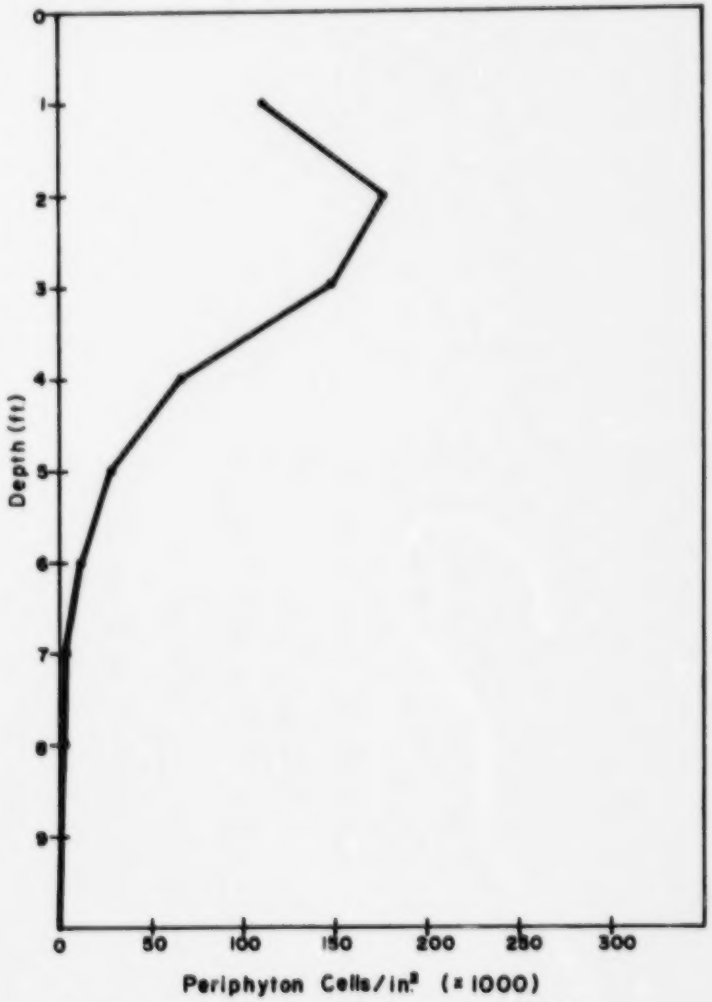


FIGURE 7. LAKE WILSON PERIPHYTON.

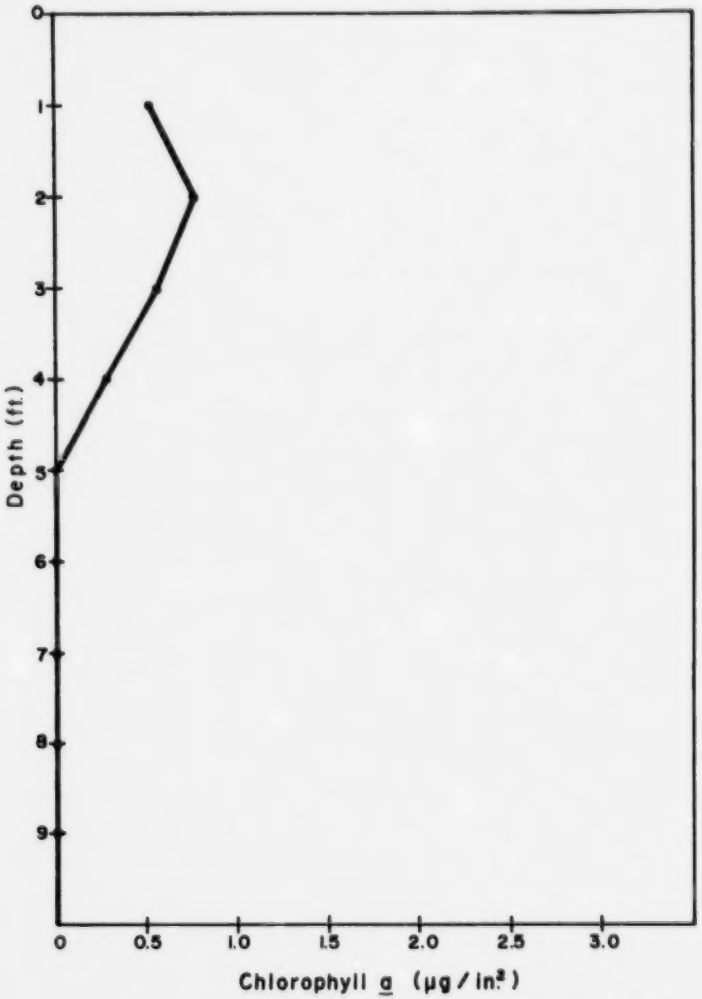


FIGURE 8. WIGGINS MILL POND CHLOROPHYLL a.

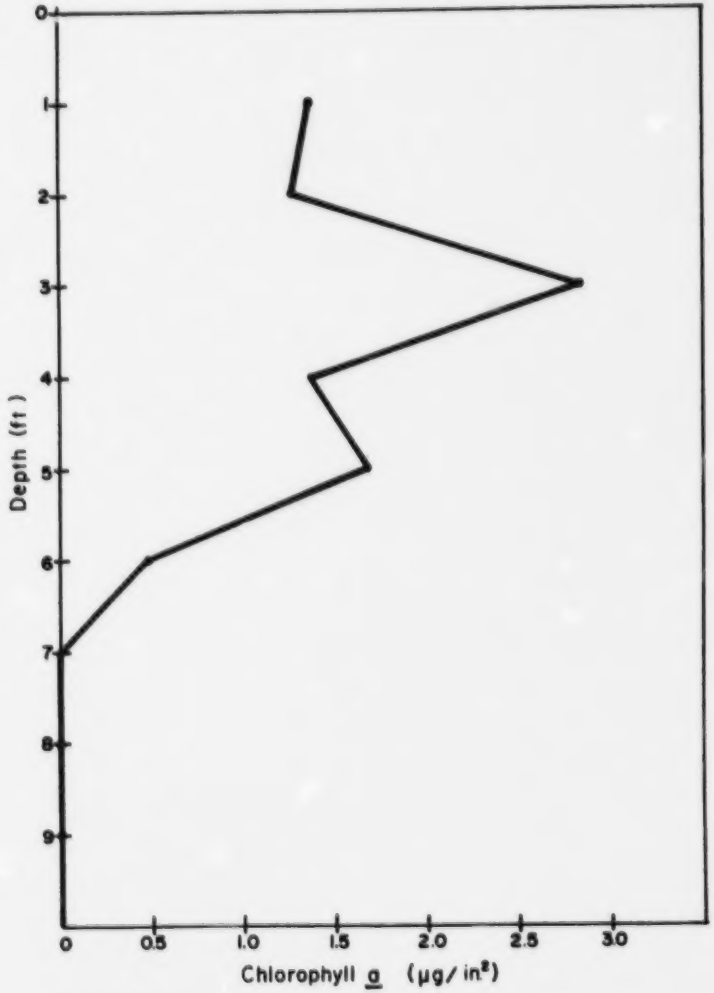


FIGURE 9. LAKE WILSON CHLOROPHYLL a.

To determine effects on dissolved oxygen concentrations in Lake Wilson and Wiggins Mill Pond by algal populations, primary production experiments were conducted. In both reservoirs, production of oxygen by algae occurred from the surface to the depth of penetration of 1 percent of incident solar radiation with a progressive decrease in oxygen production from the surface to deeper water (Figures 10 and 11). In Wiggins Mill Pond, only algae in surface water (the uppermost 1 foot) were able to produce more dissolved oxygen than was required by biotic community respiration; respiration exceeded production at all levels in Lake Wilson. Gross photosynthesis was greater in Wiggins Mill Pond than in Lake Wilson.

Photosynthesis occurred to the 1 percent insolation level in both reservoirs; this depth also approximates the mean depth (Wiggins Mill Pond, 4.6 feet; Lake Wilson, 4.1 feet) and the temporary thermocline (Figure 3) of each reservoir. All waters below the mean depths of these reservoirs are likely to be anaerobic during part of the summer. Because of the high concentrations of lignin measured in Northeast Cape Fear River waters, it is expected that the 1 percent light penetration level in Kornegay Reservoir will also be 4 to 5 feet. Only in this shallow zone would algal photosynthesis be expected to contribute dissolved oxygen

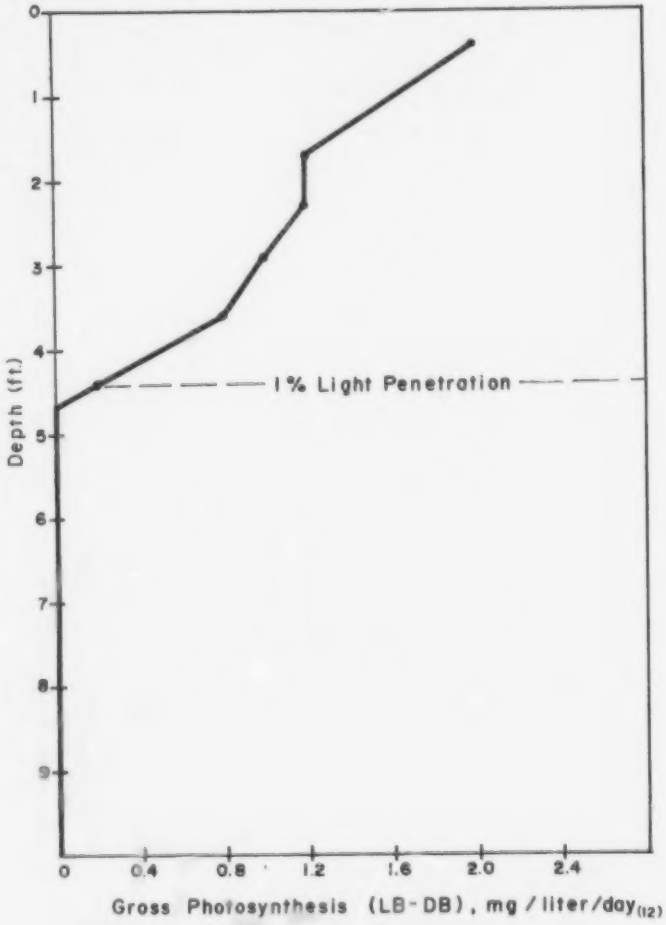


FIGURE 10. WIGGINS MILL POND GROSS PHOTOSYNTHESIS.

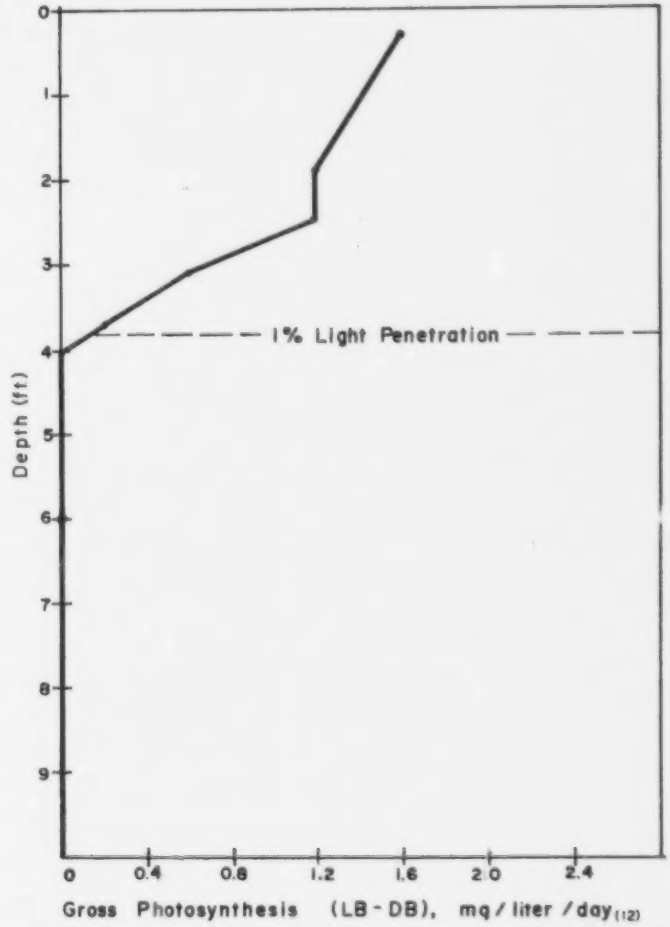


FIGURE 11. LAKE WILSON GROSS PHOTOSYNTHESIS.

to the reservoir. During the hottest summer periods, atmospheric heating and the adsorption of radiant energy by surface waters could cause the thermocline to be at shallow depths approximating those observed in Wiggins Mill Pond and Lake Wilson.

Examination of lake bed materials collected from 3 or more feet below the surface of each reservoir revealed invertebrate communities consisting of sludgeworms, chironomid midges, and phantom midge larvae (Table 16). These invertebrates typically inhabit waters containing a rich supply of organic materials, and are tolerant of low dissolved oxygen levels. Shallow shoreline areas of Lake Wilson (depth less than 3 feet), which supported rooted vascular plants (Potamogeton sp.) and beds of the alga Nitella sp., were inhabited by more diverse benthic communities consisting of the above named invertebrates plus up to six other forms. The benthos populations of both Wiggins Mill Pond (range 40-390 organisms/ft^2) and Lake Wilson (range 36-310 organisms/ft^2) were low, and constituted a poor supply of food for fishes because of a predominance of burrowing forms. The numbers of fish reportedly taken by local fishermen probably receive additional nourishment from allochthonous sources. such as terrestrial and arborial insects that fall into the reservoirs.

SOIL LEACHING STUDIES

Impounding water may result in the leaching of undesirable materials from the flooded soils. When present in excessive concentrations, these materials can interfere with desired water uses. Investigations were made during these studies to ascertain if significant quantities of materials important to water quality might be leached from the flood-plain soils present in the reach of the Northeast Cape Fear River subject to proposed impoundment. Five water quality constituents were investigated; additional information on their effects on water quality may be found in Anonymous (1962), Anonymous (1968) and APHA, et al. (1965).

(1) Color is important in water supply sources because it is objectionable aesthetically. The maximum recommended limit in Water Quality Criteria is 75 units in raw water, and, less than 10 units in finished water are desirable. Complaints from consumers occur at 15 units and increase with additional color. The measurement of color is based on an empirical scale that is affected by the true color of the water, as well as the material suspended in the water. In these investigations, lignin analyses were related to color (Figure 12) because the principal color imparting materials in the dark-brown waters of this

region are organic materials leached from the swamplands of the watershed. By comparing lignin concentrations rather than the arbitrary color unit, quantitative changes can be measured.

(2) Iron in water supplies should not exceed 0.3 mg/l, and its absence in finished water is desirable. In excess, it stains laundry, produces a disagreeable taste, interferes with filtration, and supports iron bacterial growths within a water system. The amount of iron present in water is dependent upon other chemical characteristics of the water:

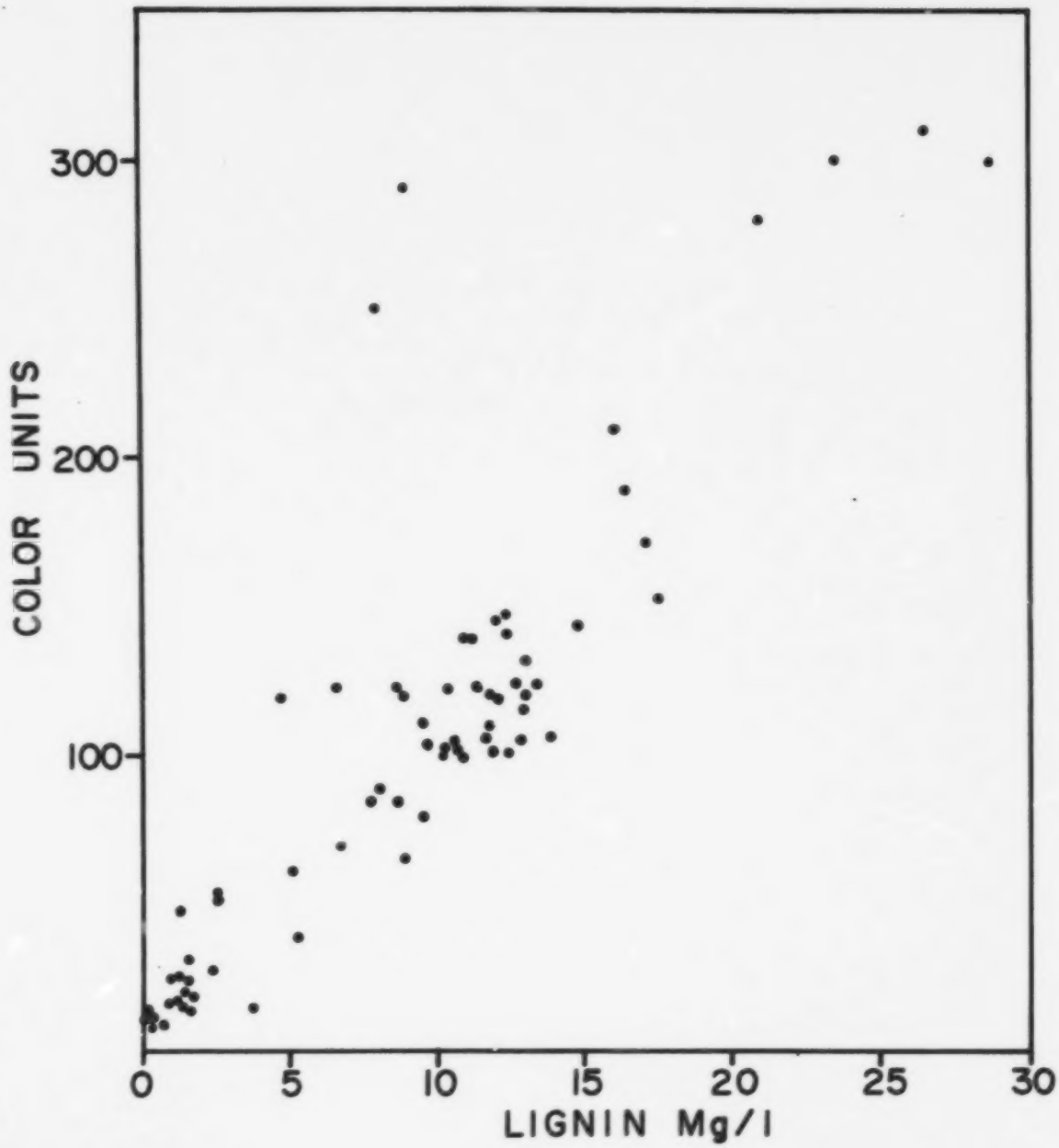
(a) It is more soluble when oxygen is absent.

(b) It is more soluble in acidic waters.

(c) Organic materials increase its solubility.

(3) Manganese should not exceed 0.05 mg/l in raw water and should be absent from finished water because of stains imparted to laundry, and objectionable tastes. Factors that affect its quantity in water are similar to those for iron.

(4) Phosphorus concentrations in excess of 0.1 mg/l may interfere with coagulation in water treatment plants, and in excess of 0.05 mg/l in water supplies may stimulate the growth of excessive algae and other aquatic plants. Excessive growths impart undesirable tastes and



SCATTER DIAGRAM
LEACHING STUDIES
COLOR vs LIGNIN
FIGURE 12.

odors to water, interfere with water treatment, become aesthetically unpleasing, interfere with recreation and aquatic life, and alter the chemistry of waterways.

(5) The chemical state of nitrogen is dependent on the overall limnology of the waterway. The decomposition of organic materials produces ammonia that, in an environment without abundant oxygen, may not be oxidized to nitrate; ammonia reacts with chlorine to form chloramines which interfere with disinfection. In addition, nitrogen is a nutrient that supports excessive aquatic vegetation that can interfere with water uses.

To determine the susceptibility of various soils from the Kornegay Reservoir site to leaching of materials to overlying waters, an experiment was conducted. Four soils (sand, loam, muck, and leaf litter) were exposed for ten days to Northeast Cape Fear River water (dark) under both aerobic and anaerobic conditions. A parallel study was conducted using non-colored (clear) waters from a borrow pit near Wilson, N. C. Additional information on experimental design and methods is located in the appendix.

RESULTS

Lignin (Color)

Lignin, a principal component of color, was reduced in the dark water overlying each of the soils except the leaf litter where the concentration of lignin continued to increase throughout the 10-day period of study (Figure 13). Lignin decreased in the dark water overlying soils other than the leaf litter; a result of biochemical degradation (Raabe, 1968).

In the clear water experiments, lignin concentrations were significantly greater after ten days of leaching. The amount of lignin increased at a faster rate with soils of high organic content than with soils of lower organic content. After ten days, the leaf litter and muck had added sufficient lignin to the clear water so that concentrations were nearly equal to those in the dark Northeast Cape Fear water.

Lignin data indicate the dark Northeast Cape Fear River water had lignin concentrations in equilibrium with each of the soils except the leaf litter, which would leach additional lignin to the water. In contrast, clear water initially containing little lignin (color), could leach sufficient lignin from each soil type to increase the color and damage a water supply.

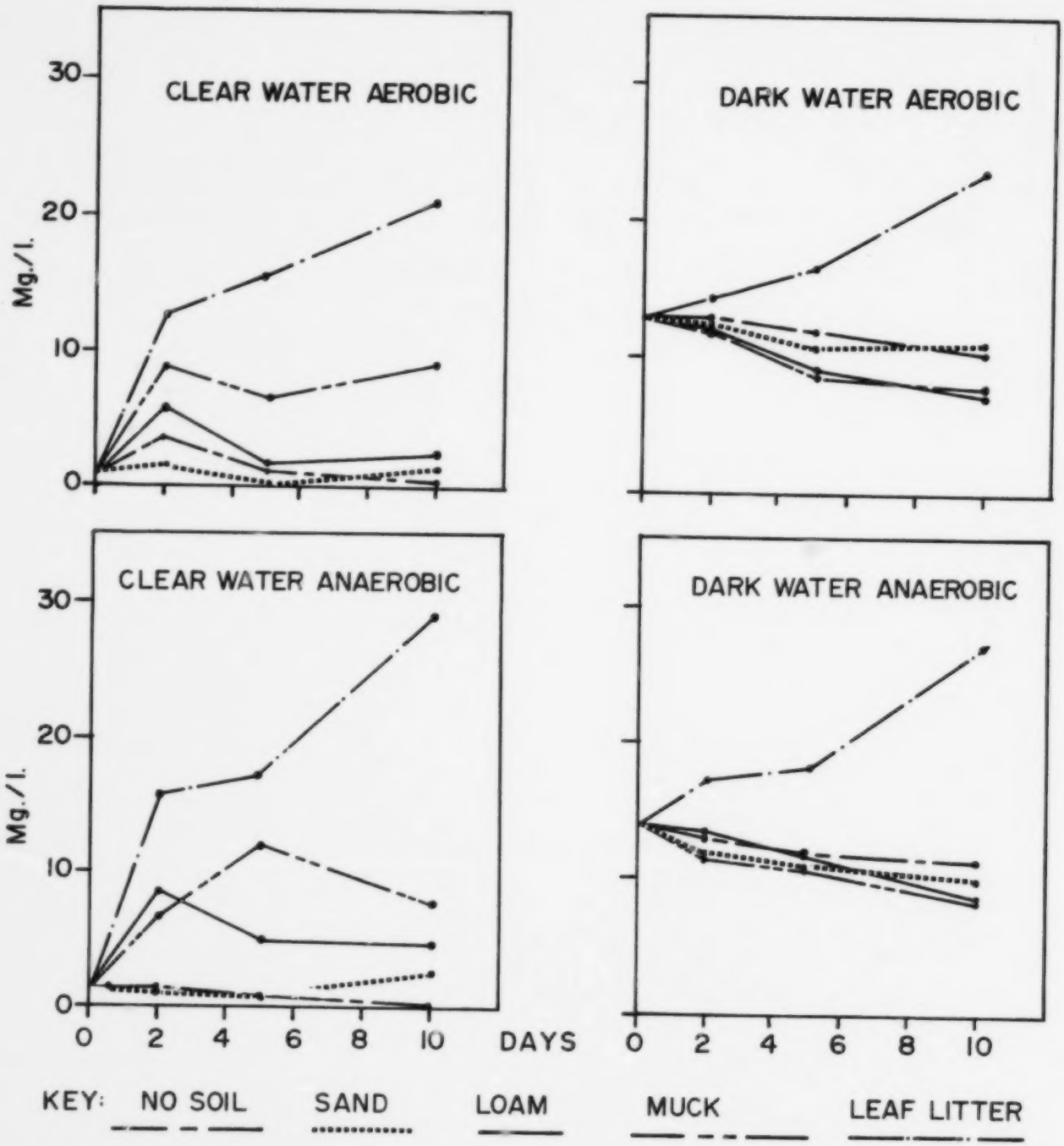


FIGURE 13. LIGNIN LEACHED FROM SOILS.

Iron

In the dark water experiments, iron concentrations increased when the leaf litter was leached; with other soils, there was a tendency for the iron concentrations to decrease (Figure 14). In the clear water experiments, iron increased with all the soils except sand; the increases were proportional to the quantities of organic matter in the soils. Iron concentrations are probably related to the concentrations of organic colloids in the water (Ruttner, 1953). In the dark water experiments, a biochemical reduction of organic materials was indicated by a decrease in iron; in contrast, the clear waters continued to leach organic material with a subsequent increase in the iron concentrations. Lignin concentrations also exhibited this trend, whereby the two waters (dark and clear) after ten days had similar concentrations of organic materials.

Iron concentrations were higher in both the clear and the dark anaerobic waters than they were in the aerobic waters.

Water quality degradation resulting from increased iron would be evident in clear water impounded over organic rich soils. Little change would be expected in the impoundment of already iron-rich Northeast Cape Fear River water, unless large quantities of leaf-litter are present at the mud-water interface.

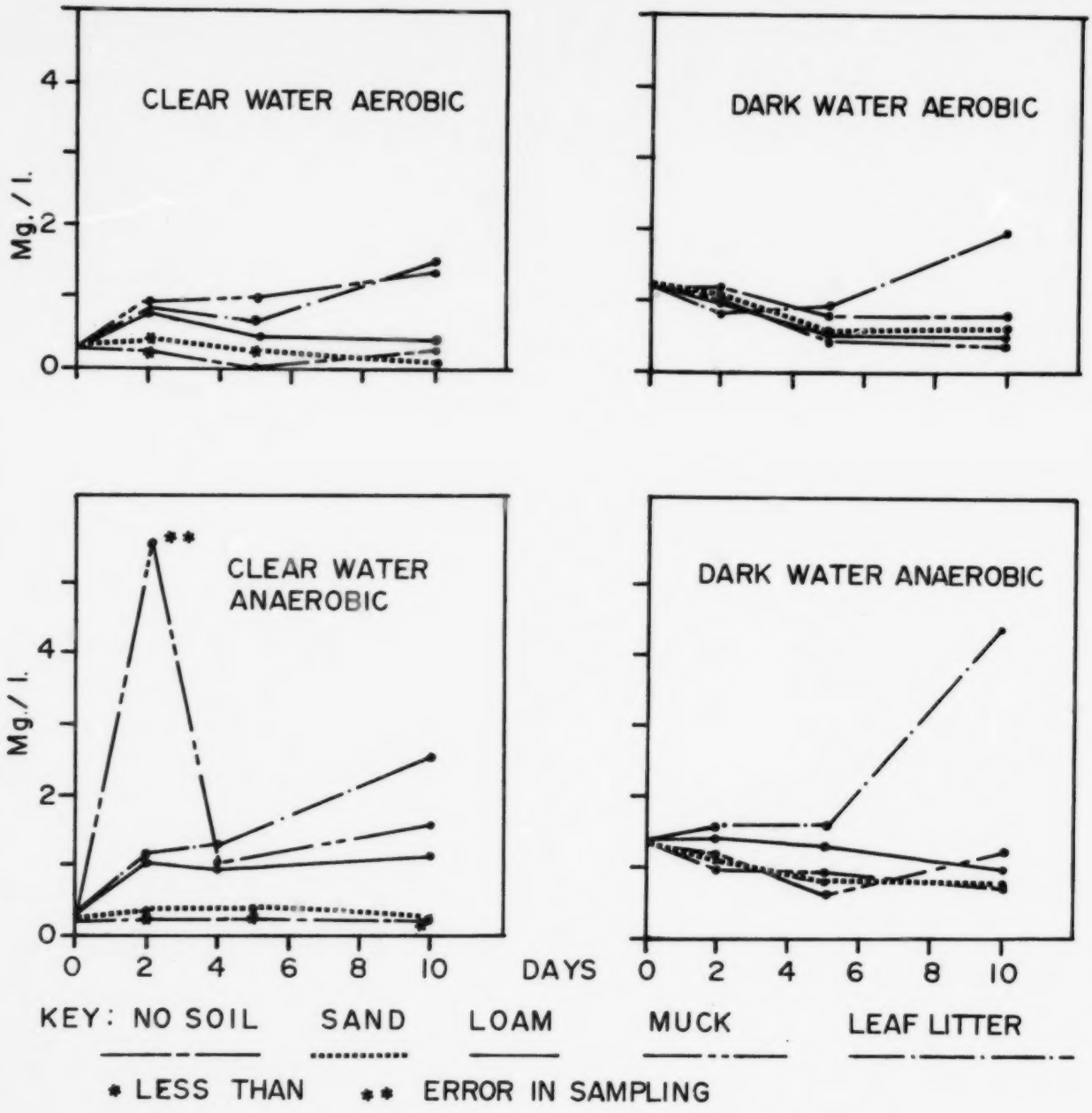


FIGURE 14. IRON LEACHED FROM SOILS.

Manganese

Manganese concentrations were higher in the clear water (0.1 mg/l) than in the dark water (.04 mg/l) at the start of the studies. In the aerobic water, manganese was reduced in concentration except in the dark water overlying muck or leaf litter; the leaf litter increased the manganese concentration by 200 percent (Figure 15).

The anaerobic clear water samples after ten days contained equal or lower manganese concentrations than at the start of the experiment, but, for all soil types this decrease was less than in the aerobic water. In the dark anaerobic water, the soils tended to increase the manganese concentrations slightly with the exception of the leaf litter, which increased the concentration 600 percent.

With the exception of the organically rich soil experiments, especially the leaf litter, manganese concentrations tended to decrease in the aerobic dark waters. However, some increases occurred in anaerobic dark water; the increase with leaf litter was very significant. The increases in manganese concentrations indicate that leaf litter should be removed from the reservoir site because, within two days of the start of the experiment, concentrations were greater than those

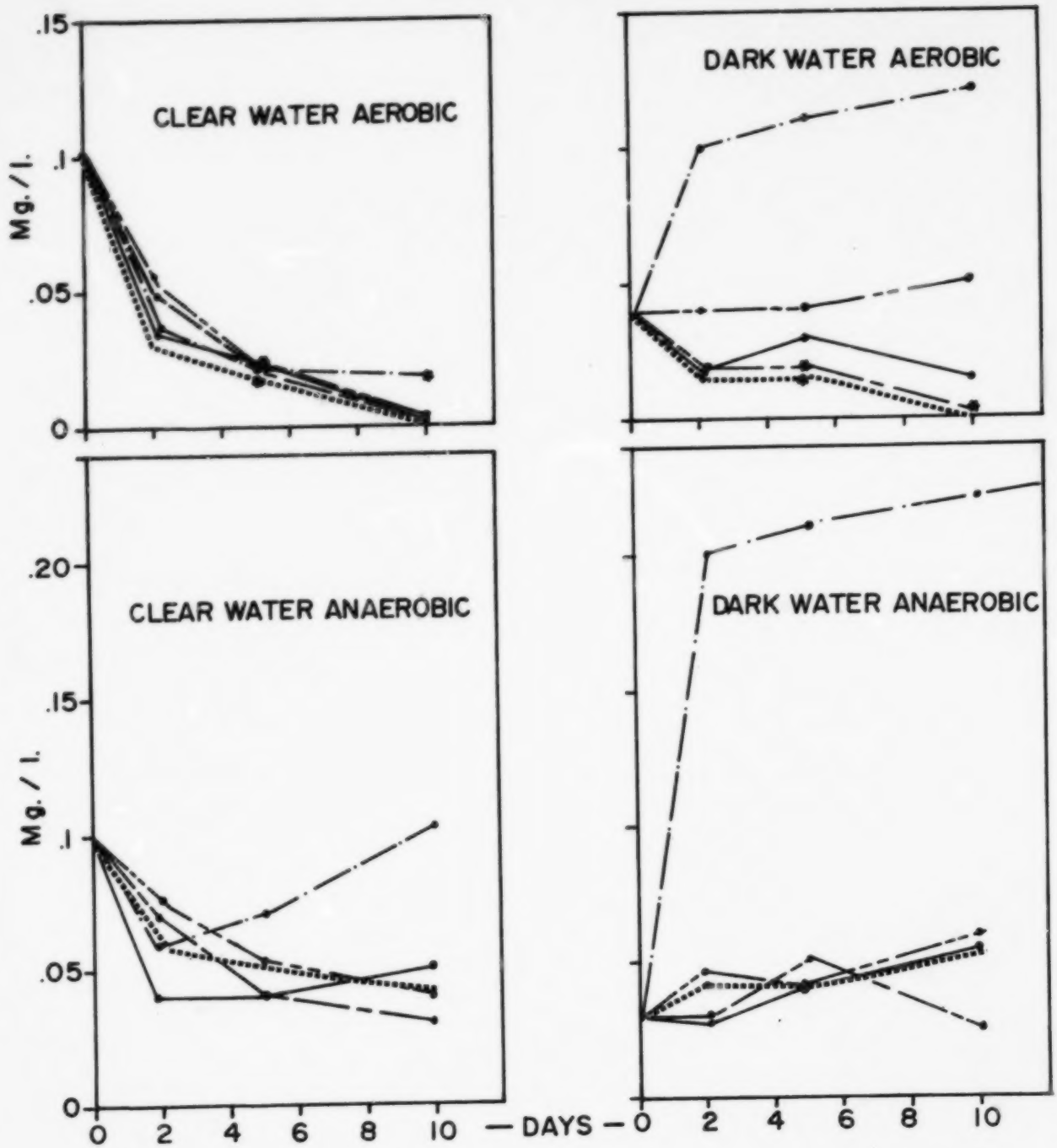


FIGURE 15. MANGANESE LEACHED FROM SOILS.

recommended in Water Quality Criteria for water supplies. Anaerobic waters also increased the manganese concentrations above the recommended .05 mg/l limit of concentration.

Phosphorus

The clear water initially had a low phosphorus concentration (0.05 mg/l). The addition of soil increased the phosphorus content. The more organic material in the soil, the greater was the increase. Anaerobic water increased phosphorus concentrations significantly more than did the concentrations in aerobic water (Figure 16).

The dark Northeast Cape Fear River water was phosphorus rich (0.25 mg/l); and, with the exception of leaf litter, concentrations decreased with time. The dark water changes in phosphorus concentration generally paralleled those observed for the lignin, indicating that phosphorus is active in the biochemical degradation of organic compounds in the dark water resulting in an eventual movement of phosphorus to the sediments.

In the phosphorus-rich dark waters, the tendency was for the phosphorus concentrations to reduce. An exception to this decrease

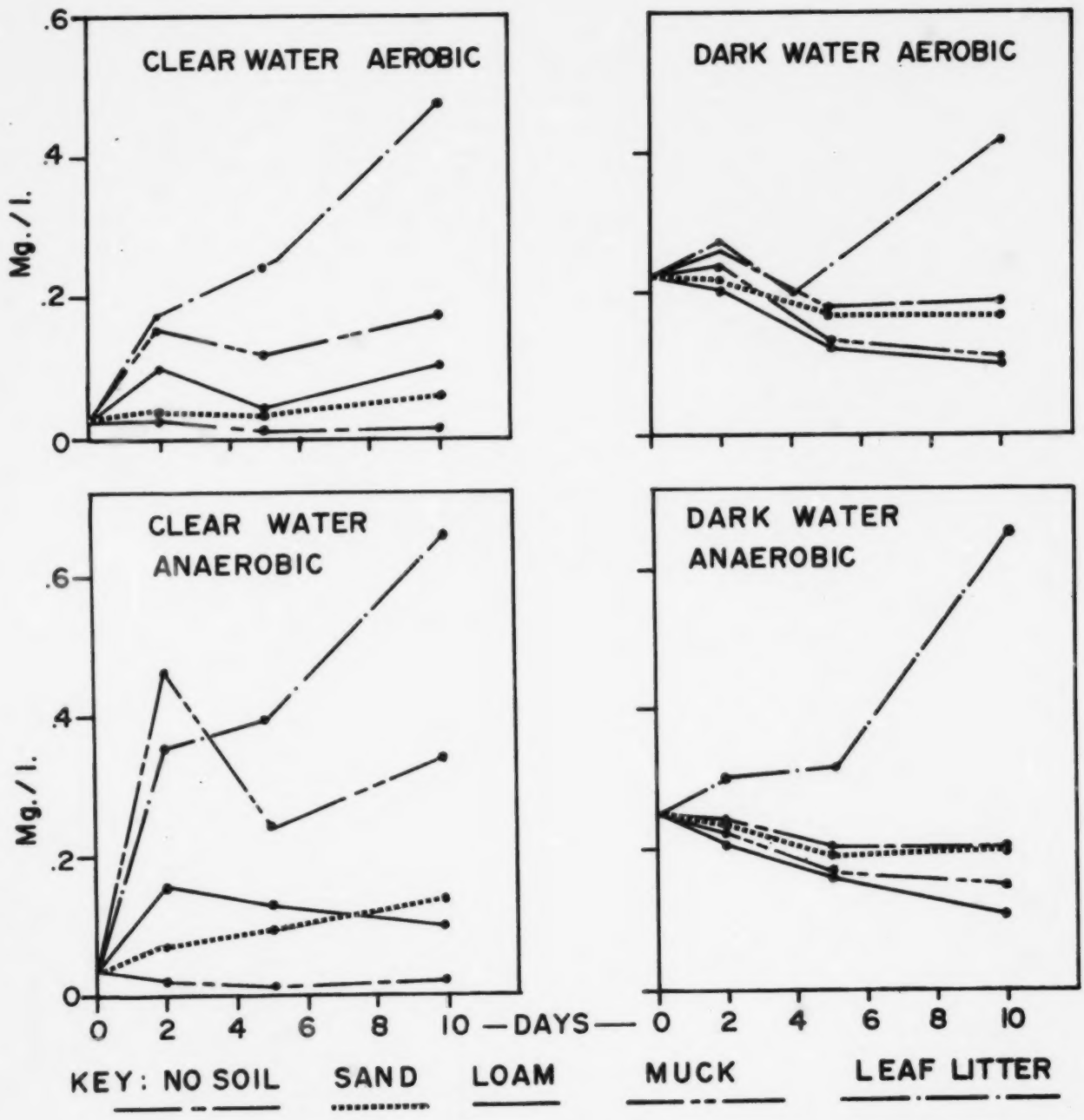


FIGURE 16. TOTAL PHOSPHORUS LEACHED FROM SOILS.

was with the phosphorus rich leaf litter. After a few years of impoundment, phosphorus concentrations should tend to decrease as biological growths assimilate phosphorus, settle to the bottom, and are incorporated into the sediments. There may be aquatic growth stimulation in many other environments, but the Northeast Cape Fear River's dark water should limit this stimulation because of poor light penetration.

Nitrogen

Total nitrogen concentrations increased in the initially nitrogen-poor clear water (Figure 17). The more organic nitrogen in the soil, the greater was the increase. Increases were also greater in anaerobic water than in aerobic water.

Dark Northeast Cape Fear River water initially contained abundant nitrogen (2 mg/l). In the aerobic dark water, all tests except those with loam indicated a decrease in total nitrogen by the fifth day; but, by the tenth day, concentrations had returned to near the initial concentration. In anaerobic water, there was a slight tendency for nitrogen concentrations to decrease.

Nitrogen in the water of the Northeast Cape Fear River may be in equilibrium with the nitrogen in the soils to be flooded; changes that

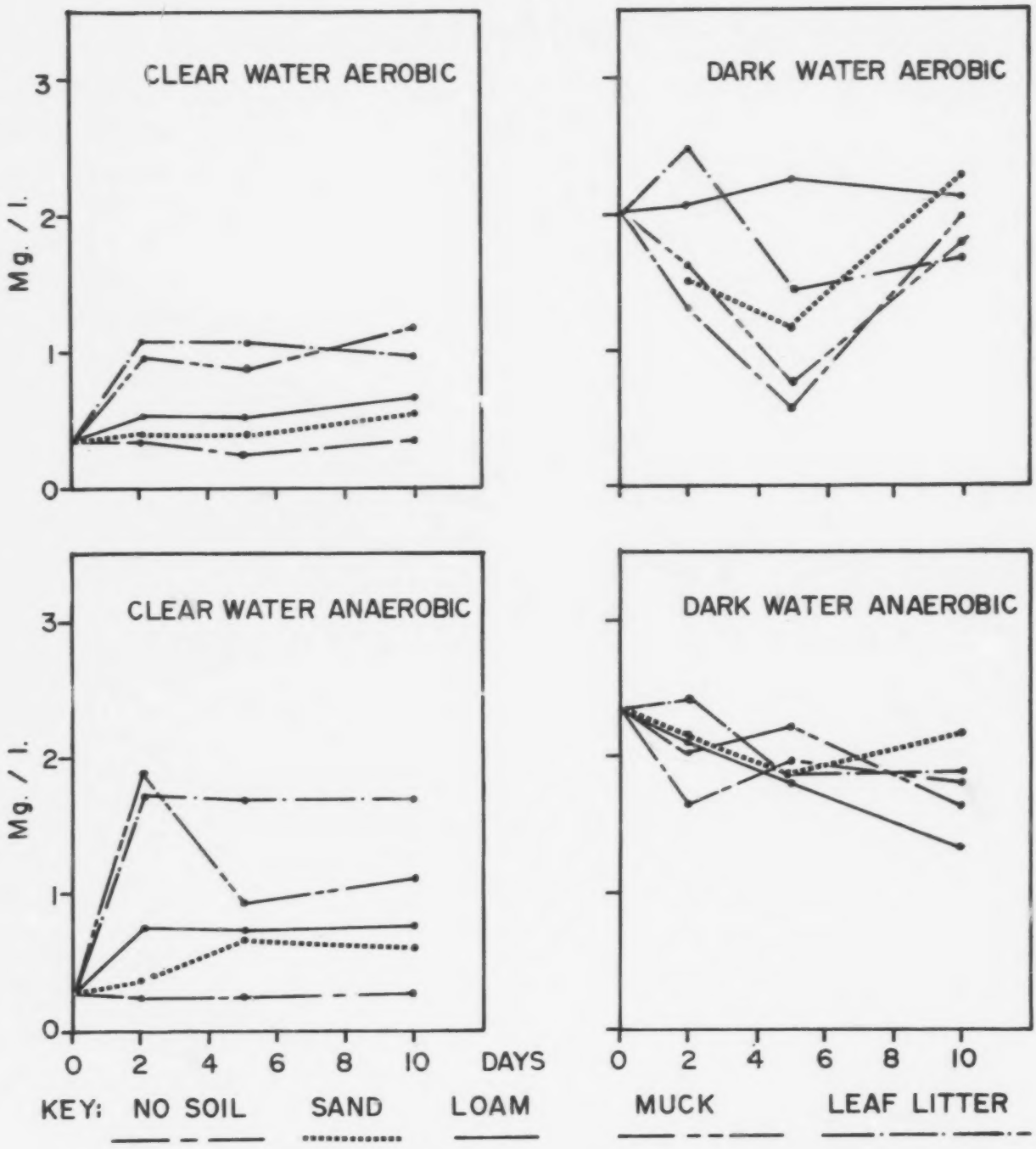


FIGURE 17. TOTAL NITROGEN LEACHED FROM SOILS.

may occur after impoundment could not be predicted on available information, and would be more dependent on other factors such as pollution, fixation of atmospheric nitrogen, etc. In other waters with low nitrogen concentrations (< 1 mg/l), sufficient nitrogen could be leached to increase the production of aquatic life.

ACKNOWLEDGEMENTS

This study was conducted cooperatively by the Technical Advisory and Investigations (TA&I) Branch of FWPCA, the Middle Atlantic Region of FWPCA, and the Wilmington, North Carolina District of the Army Corps of Engineers. Field studies were conducted by TA&I Branch and Middle Atlantic Region personnel. Stream sampling and flow measurements were performed by Army Corps of Engineers personnel. Samples for chemical analyses were either preserved and shipped to the TA&I Branch laboratory at Cincinnati, Ohio, or were analyzed in a mobile laboratory operating at the Wilson, North Carolina, sewage treatment plant. The soil leaching studies were conducted at the treatment plant by TA&I Branch personnel. This report was written by the Technical Advisory and Investigations Branch of FWPCA.

Participants in the study were:

1. TA&I Branch, FWPCA.

   L. E. Keup, Aquatic Biologist; R. K. Ballentine, Sanitary Engineer; R. W. Warner, Aquatic Biologist; E. W. Raabe, Chemist; and G. D. McKee, Chemist.

2. Middle Atlantic Region, FWPCA.

   J. S. Hall, Sanitary Engineer

3. Wilmington, N. C. District Army Corps of Engineers.

   L. Rogers, Hydraulic Engineer

The cooperation of the City of Wilson, North Carolina, in providing facilities at the city sewage treatment plant, a boat, outboard motor, and lake access is appreciated.

APPENDIX

METHODS

Water Sampling

A schematic diagram of sampling station locations and designations on the Northeast Cape Fear River, Contentnea Creek, and Toisnot Creek is shown in Figure 1. Both Wiggins Mill Pond and Lake Wilson discharge surface waters; these surface discharges were sampled routinely at stations CC-8 (Wiggins Mill Pond) and T-10 (Lake Wilson) and chemical data from them were reported as those for reservoir surface waters. Figure 2 shows the locations of sampling stations on Wiggins Mill Pond and Lake Wilson.

Water samples were collected daily at each sampling station, iced, and transported to a mobile chemical laboratory at the Wilson, N. C., sewage treatment plant. Aliquots were preserved and shipped to the TA&I Branch laboratory for nutrients and metals analyses. Other chemical analyses were performed in the mobile laboratory.

Morphometry

Hydrographic maps of Wiggins Mill Pond and Lake Wilson were prepared from recordings made along transects of these reservoirs, using a Bludworth Marine Model ES130 Portable Echo Sounding Survey Recorder.[1]

---

[1] Mention of a commercial product does not constitute endorsement by the Federal Water Pollution Control Administration, United States Department of the Interior.

Chemical

Analyses for all chemical constituents measured, except for nutrients, metals, and some dissolved oxygen determinations, were performed as outlined in "Standard Methods" (A.P.H.A. et al. 1965).

Ammonia-nitrogen, nitrate, and total and soluble phosphorus were determined on a Technicon Autoanalyzer.

The phenolate method with the addition of nitroprusside (Ternberg and Hershey, 1960) was used for ammonia-nitrogen determinations. Organic nitrogen was measured by the Micro-Kjeldahl procedure (Kabat and Mayer, 1948) with preliminary discharge of ammonia-nitrogen at pH 7.4. Nitrate nitrogen was determined manually by the method of Jenkins and Medsker (1964).

The ammonium molybdate-stannous chloride procedure (Kramer and Gale, 1964) was used to determine phosphorus concentrations. Soluble phosphorus was determined by examination of the filtrate, after filtration through a membrane filter of 0.45 millimicron pore size.

All nitrogen (N) and phosphorus (P) data were reported as the quantity of the element; not the ionic state.

Heavy metals were determined by atomic absorption using a Perkin-Elmer Model 303 instrument, operated according to the manufacturer's instructions and methodology manual.

Temperature and dissolved oxygen (D. O.) profiles in both Wiggins Mill Pond and Lake Wilson were determined on three occasions. Dissolved oxygen concentrations were determined with a Weston and Stack D. O. Analyzer. This instrument was standardized using methods outlined in "Standard Methods" (A.P.H.A. et al., 1965). Temperatures were measured with a thermistor attached to the D. O. probe. Temperatures and D. O. were measured along transects perpendicular to the long axes of the lakes.

Bottom Oxygen Demand

Rates of oxygen demand by bottom materials were measured with an experimental, in situ benthic respirometer. The respirometer consisted of a clear plexiglass chamber that was lowered and inserted into the lake bed. A pump circulated the water in the chamber over the bottom and past a dissolved oxygen (D. O.) probe which continuously monitored D. O. concentrations. Bottom oxygen demand rates were calculated from the changes of D. O. concentrations measured in the circulated water.

Biological

Water samples containing plankton were collected in Kemmerer bottles, transferred to liter bottles, and preserved by adding formalin

to effect 5 percent formalin solutions. Counting of plankton was by direct count (no concentration of samples) of one milliliter aliquots in a Sedgwick-Rafter Counting Cell (A.P.H.A. et al., 1965).

Periphyton, or attached algal growths, were sampled in Wiggins Mill Pond and Lake Wilson using artificial substrates. These substrates consisted of groups of four glass microscope slides suspended at each 1 foot interval from the surfaces of the reservoirs to the lake beds. After a 13 day exposure period (26 July - 7 August, 1968), the substrates were removed from the reservoirs. Two slides from each group were scraped free of periphyton and preserved in 5 percent formalin solution. The suspensions of algal cells were adjusted to known volumes, and aliquots were counted in a Sedgwick-Rafter Counting Cell (A.P.H.A. et al., 1965). Results were expressed as algal cells per square inch of substrate. The other two microscope slides were placed in 90 percent acetone solution. Chlorophyll *a* concentrations in these solutions were determined with a Beckman Model DB spectrophotometer using procedures described by Richards with Thompson (1952). Results were expressed as micrograms per square inch of substrate.

Penetration of incident sunlight was measured in each reservoir by submerging a photoelectric cell, encased in a waterproof housing, and

recording electrical output at 1 foot intervals from the surface to the bottom. Primary production rates were measured by suspending racks of light and dark bottles containing surface water of the reservoir being studied at various levels between the surface and the depth of penetration of 1 percent of incident sunlight. Two of the glass-stoppered bottles suspended at each level were clear; algal photosynthesis and biotic respiration could proceed in these bottles if insolation was sufficient. The other two bottles at each level were covered with aluminum foil to exclude sunlight. Dissolved oxygen concentrations in the bottles were measured at the start of the experiment. The racks containing bottles were suspended in the reservoirs for 6 hours (from 1000 to 1600). Respiration at each level was the difference between the initial D. O. concentration and that in the dark bottles at the end of the exposure period. Gross photosynthesis at each level was the difference between the D. O. concentration of the light (clear) bottles and that of the dark bottles at the end of the exposure period (Gaarder and Gran, 1927). Results were extrapolated and expressed as respiration and gross photosynthesis/liter/12 hour day.

Lake bed inhabiting invertebrate animals (benthos) were collected in an Ekman dredge (A.P.H.A. et al., 1965). Samples were screened on a

No. 30 U. S. Standard Series sieve. Those animals retained on the sieve are considered in this report.

Soil Leaching Studies

An experiment was undertaken to determine the susceptibility of flood-plain soils for leaching materials by oxygenated (aerobic) overlying water such as may be expected in the surface layers of the reservoir during the summer period of thermal stratification and in the entire water mass when well circulated, and by water without dissolved oxygen (anaerobic) such as may be expected during periods of weak circulation and in the deeper stagnant waters during summer thermal stratification. Four soil types common to the river bottom lands were selected:

1. Sand - Selected from sand barr deposited on the Northeast Cape Fear River flood-plain.
2. Loam - A mixture of sand, silt and clay.
3. Muck - A mixture of silt and clay with much organic material incorporated.
4. Leaf Litter - Highly decomposed plant detritus that overlies much of the river bottom lands.

Chemical characteristics of these soils were as follows:

Soil	% Moisture	% Carbon	% Nitrogen	% Phosphorus
Sand	2.57	0.19	0.02	0.005
Loam	23.76	2.7	0.19	0.02
Muck	46.36	7.3	0.52	0.04
Leaf Litter	63.32	28.3	1.63	0.11

Four hundred grams (wet weight) of each soil type was placed in five gallon carboys. Sixteen liters of water were added to the carboy. In half the carboys an oxygenated environment was maintained by aeration with compressed air. In the remaining carboys, an anaerobic environment was produced by bubbling nitrogen through the water. A nitrogen atmosphere was maintained by sealing the carboy. A vent (protected from the air with a water-filled air lock) was provided to allow the escape of gases generated by decomposition in the jar. Water for analyses was withdrawn from the sealed carboys by siphons and nitrogen gas replaced the volume of water withdrawn.

Aerobic and anaerobic environments were also established without soil added to the carboys, thereby providing information on changes that might occur in the water without the soil effects (Table 17).

Since the water of the Northeast Cape Fear River is highly colored and may react differently with soils than other waters, another series of carboys was maintained using a less colored water. Clear water was selected from borrow-pit sources to approximate the chemical characteristics of Northeast Cape Fear water (dark), with the exception of color. The chemical characteristics of the two waters were as follows:

	Dark Water	Clear Water
pH	5.9 units	6.8 units
Total alkalinity	8 mg/l	12.0 mg/l
Acidity	4 mg/l	2.0 mg/l
Ammonia nitrogen	0.25 mg/l	0.04 mg/l
Nitrate N	1.2 mg/l	< 0.1 mg/l
Organic N	0.55 mg/l	0.28 mg/l
Total phosphorus	0.22 mg/l	0.02 mg/l
Lignin	12.8 mg/l	1.2 mg/l
Color	104 units	18 units

This resulted in a total of twenty bottles designated as follows:

	Dark		Clear	
	Northeast Cape Fear Water		Borrow Pit Water	
	Aerobic	Anaerobic	Aerobic	Anaerobic
No soil	10 AO*	10 NO	9 AO	9 NO
Sand	4 AS	4 NS	3 AS	3 NS
Loam	6 AD	6 ND	5 AD	5 ND
Muck	8 AM	8 NM	7 AM	7 NM
Leaf litter	2 AL	2 NL	1 AL	1 NL

* Laboratory sample number

The experimental carboys were covered with black polyethylene sheeting to exclude light, thus eliminating effects of photosynthesis. Room temperatures (75 - 80°F) were used. On the second, fifth, and tenth days, 1200 ml water samples were removed from the carboys for chemical analyses.

Chemical changes observed are summarized in Figures 9 through 13. No adjustments have been made in these presentations for the volume of water withdrawn for analyses or for the moisture present in the soils. Data are presented in Tables 18-21. The illustrated curves do not

indicate that these volume or moisture adjustments would have merit. Material leached was not at a steady rate and the moisture present in the soil was a small percentage of the total water volume (maximum < 2 percent).

REFERENCES

American Public Health Association, et al.

1965. Standard Methods for the Examination of Water and Wastewater. Amer. Public Health Assoc., N. Y., N. Y., xxxi + 769 pp.

Anonymous

1962. Public Health Service Drinking Water Standards. Dept. Health, Education & Welfare, Public Health Service, Washington, D. C., vii + 61 pp.

Anonymous

1968. Water Quality Criteria. Fed. Water Pollution Control Admin., Washington, D. C., x + 234 pp.

Gaarder, T. and Gran, H. H.

1927. Investigations of the production of plankton in the Oslo Fjord. Rapp. et Proc. Verb., Cons. Internatl. Explor. Mer., 42:1.

Jenkens, D. and L. L. Medsker

1964. Brucine method for the determination of nitrate in ocean, estuarine, and fresh waters. Analytical Chemistry, 36(3): 610-612.

Kabat, E. A. and M. Mayer

1948. Kjeldahl nitrogen determination. Chapter 12, pp. 282-291 in: Experimental Immunochemistry. C. Thomas, Springfield, Ill., 567 pp.

Kroner, R. C. and M. E. Gale

1964. Determination of phosphate, nitrate, and alkylbenzene sulfonates (ABS) in water with the autoanalyzer. U.S.P.H.S., Federal Water Pollution Control Administration, Water Pollution Surveillance System, Applications and Development Report No. 13.

Mackenthun, K. M., L. E. Keup, and R. K. Stewart

1968. Nutrients and Algae in Lake Sebasticook, Maine. Jour. Water Poll. Control Federation, 40(2, 2) Research Supplement: R72-R81.

Raabe, E. W.

1968. Biochemical Oxygen Demand and Degradation of Lignin in Natural Waters. Jour. Water Pollution Control Federation. Research Supplement 40(5, 2): 145-150.

Richards, F. A. with T. G. Thompson

1952. The estimation and characterization of plankton populations by pigment analysis. II. A spectrophotometric method for the estimation of plankton pigments. Jour. Marine Research, 11(2): 156.

Ruttner, F.

1953. Fundamentals of Limnology. Univ. Toronto Press. xi + 242 pp.

Ternberg, J. L. and F. B. Hershey

1960. Colorimetric determination of blood ammonia. Clinical Medicine, 56: 766-771.

Table 1. Chemical Data

Northeast Cape Fear River at Duplin Co. Road 1502

(Station CF-1)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Volatile mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2 day mg/l	BOD 5 day mg/l	D.O. mg/l	COD mg/l	Flow cfs	Gauge Ht.	Org. N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29,1980	9:20A	25	6.7	36	8	4	< 5	1290	--	--	140	13.4	1.5	4.2	4.2	190	52.8	1.82'	0.69	5.98	0.9	0.57	2.5	0.22
30	11:05A	--	6.4	12	7	5	< 5	710	--	--	140	14.4	0.7	1.7	4.7	78	51.7	1.78'	0.63	0.60	1.3	0.41	1.8	0.07
31	12:45P	24	6.4	10	6	4	5	650	--	--	140	14.8	0.1	0.6	4.4	82	50.4	1.72'	0.66	0.89	1.5	0.40	1.8	0.04
Aug. 1	1:15P	25	6.4	9	5	4	< 5	510	--	--	152	14.8	--	0.6	5.2	63	48.5	1.65'	0.65	0.13	1.8	0.48	1.4	0.03
2	7:50A	24	6.4	10	6	4	< 5	730	--	--	128	11.8	0.6	0.4	4.4	50	47.3	1.60'	0.69	0.33	2.5	0.40	1.3	0.04
5	12:30P	26	6.5	--	--	4	--	730	65	1350	124	12.8	--	--	5.0	45	44.5	1.48'	0.66	0.12	1.4	0.40	1.2	0.05
6	11:45A	25	6.5	--	--	5	--	--	--	1405	152	13.8	--	--	5.1	81	44.3	1.48'	0.65	0.10	1.3	0.42	1.4	0.06
7	1:10P	27	6.5	--	--	4	--	--	--	1344	124	13.8	--	--	4.8	42	43.7	1.45'	0.70	0.23	0.8	0.49	1.2	0.08
8	10:05A	26	6.5	--	--	4	--	--	--	1400	160	13.8	--	--	4.0	119	43.3	1.43'	0.78	0.42	1.1	0.56	1.2	0.07
9	8:10A	26	6.4	--	--	5	--	--	--	1385	148	12.4	--	--	4.2	110	42.6	1.40'	0.73	0.32	1.3	0.50	1.2	0.08
Avg.		25	6.5	16	6	4	--	770	--	1470	141	13.6	0.7	1.3	4.6	86	46.3	--	0.68	0.65	1.4	0.46	1.5	0.07
Max.		27	6.7	36	8	5	--	1290	--	1385	160	14.8	--	--	5.2	190	52.8	--	0.78	3.98	2.5	0.57	2.5	0.22
Min.		24	6.4	9	5	4	--	510	--	1350	124	11.8	--	--	4.0	45	42.6	--	0.63	0.10	0.8	0.40	1.2	0.03

Table 2. Chemical Data

Poley Branch of Northeast Cape Fear River at N. C. Highway 111

(Station PB-2)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Volatile mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2 day mg/l	BOD 5 day mg/l	D.O. mg/l	COD mg/l	Flow cfs	Gauge Ht.	Org. N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot. Phos. mg/l(P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29.1960	10:10A	23	6.1	4	4	3	< 5	50	-	--	84	8.2	0.1	0.9	9.3	24	17.2	1.42	0.34	0.06	1.1	0.05	0.5	< 0.02
30	9:30A	--	5.9	4	4	7	< 5	50	--	--	104	10.4	1.8	4.0	7.4	20	16.5	1.57	0.32	0.07	0.9	0.06	0.4	0.02
31	2:15P	23	6.1	4	4	5	5	50	--	--	90	10.4	--	--	7.4	23	18.1	1.52	0.37	0.05	0.4	0.05	0.5	< 0.02
Aug. 1	11:45A	23	6.1	4	3	4	< 5	45	--	--	88	9.6	--	--	7.8	19	17.6	1.46	0.33	0.05	1.1	0.05	0.5	< 0.02
2	6:30A	22	6.1	4	4	6	< 5	50	--	--	82	8.2	0.5	0.4	7.2	20	16.7	1.37	0.35	0.04	0.9	0.05	0.3	< 0.02
5	12:00M	25	6.2	-	-	5	-	45	25	50	82	8.8	--	--	7.0	4[1]	16.2	1.32	0.30	0.06	0.8	0.05	0.4	< 0.02
6	12:55P	25	5.9	-	-	6	-	--	--	60	82	9.4	--	--	7.2	18	16.5	1.35	0.26	0.05	0.9	0.07	0.4	< 0.02
7	11:40A	25	6.2	-	-	6	-	--	--	50	88	8.2	--	--	7.8	11	16.1	1.30	0.36	0.07	0.3	0.06	0.4	< 0.02
8	9:00A	24	6.2	-	-	6	-	--	--	50	90	9.0	--	--	6.9	20	15.7	1.26	0.36	0.05	0.5	0.06	0.3	< 0.02
9	7:05A	23	6.2	-	-	6	-	--	--	45	82	8.8	--	--	7.1	20	15.7	1.26	0.36	0.07	0.5	0.06	0.3	< 0.02
Avg.		24	6.1	4	4	6	-	55	--	50	88	9.1	0.8	1.8	7.5	19	16.8	--	0.35	0.06	0.7	0.06	0.4	--
Max.		25	6.2	4	4	7	-	90	--	60	104	10.4	--	--	9.3	--	18.5	--	0.36	0.07	1.1	0.07	0.5	--
Min.		22	5.9	4	3	3	-	45	--	45	82	8.2	--	--	6.9	--	15.7	--	0.32	0.04	0.3	0.05	0.3	--

[1]Not used in Average

Table 5. Chemical Data

N. E. Cape Fear River at Duplin Co. Road 1306

(Station CF-5)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Volatile mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2-day mg/l	BOD 5-day mg/l	D.O. mg/l	COD mg/l	Flow cfs	Gage Ht.	Org. N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29,1968	9:55A	25	6.5	10	5	5	< 5	720	--	--	150	11.6	--	--	9.2	50	115	3.61	0.72	0.2	1.5	0.32	1.4	0.05
30	10:40A	--	6.5	10	4	6	< 5	620	--	--	136	13.4	--	--	6.6	59	120	3.78	0.43	0.48	1.1	0.25	1.2	0.06
31	1:00P	24	6.4	8	4	6	< 5	590	--	--	144	13.4	--	--	6.8	66	115.5	3.62	0.44	0.18	0.7	0.27	1.2	0.04
Aug. 1	12:45P	25	6.6	8	4	6	< 5	460	--	--	136	14.4	--	--	7.2	58	113	3.54	0.42	0.06	1.7	0.33	1.3	0.05
2	7:30A	24	6.5	9	3	6	< 5	460	--	--	136	13.0	--	--	6.8	40	110.5	3.42	0.52	0.03	2.2	0.35	1.4	0.02
5	12:15P	25	6.6	--	-	6	-	585	40	1120	108	13.2	--	--	6.5	62	107	3.26	0.60	0.08	1.5	0.30	0.9	0.04
6	12:40P	26	6.4	--	-	5	-	-	--	1250	124	12.6	--	--	6.8	68	107	3.25	0.64	0.05	1.1	0.30	1.0	0.04
7	12:50P	27	6.6	--	-	5	-	-	--	1255	128	12.2	--	--	6.0	40	107	3.24	0.64	0.06	0.8	0.36	1.2	0.05
8	9:50A	26	6.6	--	-	5	-	-	--	1360	116	12.8	--	--	6.9	100	106	3.16	0.70	0.06	0.7	0.36	1.0	0.04
9	7:55A	26	6.6	--	-	5	-	-	--	1325	124	13.0	--	--	6.8	69	105	3.15	0.62	0.09	1.2	0.41	1.2	0.04
Avg.		25	6.5	9	4	6	-	570	--	1260	130	13.0	--	--	7.0	61	110.6	--	0.57	0.13	1.2	0.32	1.2	0.04
Max.		27	6.6	10	5	6	-	720	--	1360	150	14.4	--	--	9.2	100	120	--	0.72	0.48	2.2	0.41	1.4	0.06
Min.		24	6.4	8	3	5	-	460	--	1120	108	11.6	--	--	6.5	40	105	--	0.42	0.03	0.7	0.25	0.9	0.02

Table 4. Chemical Data

N. E. Cape Fear River at Duplin Co. Road 1519 (Station CF-4)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Volatile mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2-day mg/l	BOD 5-day mg/l	D.O. mg/l	COD mg/l	Flow cfs	Gauge Ht.	Org. N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29,1[illegible]	10:30A	25	6.5	[illegible]	5	4	< 5	570	--	--	172	11.2	0.2	0.2	4.2	63	127	2.58	0.54	0.09	1.0	0.26	1.2	0.03
30	10:15A	--	6.5	11	4	8	10	560	--	--	132	14.4	0.8	1.6	6.8	62	165	3.41	0.60	0.69	0.5	0.25	1.4	0.05
31	1:30P	24	6.2	[illegible]	5	5	5	560	--	--	150	15.0	--	--	7.0	52	151	3.08	0.53	0.12	0.5	0.20	1.1	0.03
Aug. 1	12:30P	24	6.6	[illegible]	4	5	< 5	430	--	--	152	13.8	--	0.1	7.2	52	134	2.69	0.37	0.06	1.4	0.25	1.1	0.03
2	7:20A	24	6.5	[illegible]	4	5	< 5	410	--	--	152	12.4	0.1	--	6.9	56	127	2.54	0.41	0.05	1.2	0.26	1.4	0.02
5	11:30A	26	6.6	-	-	5	-	550	40	1015	100	13.2	--	--	6.8	56	118	2.25	0.54	0.04	1.4	0.27	0.[illegible]	0.02
6	12:00N	26	6.6	-	-	5	-	-	--	1240	104	10.8	--	--	7.4	60	116	2.20	0.50	0.05	0.7	0.26	1.0	0.04
7	12:40P	27	6.6	-	-	4	-	-	--	1335	104	11.4	--	--	7.5	65	116	2.20	0.52	0.05	0.[illegible]	0.27	0.7	0.04
8	8:15A	26	6.5	-	-	4	-	-	--	1230	100	11.2	--	--	6.8	61	110	2.14	0.60	0.05	0.[illegible]	0.31	1.0	0.02
9	7:45	26	6.6	-	-	5	-	-	--	1255	132	11.4	--	--	6.9	63	108	2.10	0.66	0.05	0.9	0.32	1.1	0.03
Avg.		25	6.5	3	4	5	-	477	--	1213	130	12.1	0.3	0.6	7.2	57	127	--	0.55	0.12	1.0	0.27	1.1	0.03
Max.		27	6.6	11	5	8	-	570	--	1335	172	15.0	--	--	9.2	65	165	--	0.86	0.69	1.4	0.32	1.4	0.05
Min.		24	6.2	[illegible]	3	4	-	390	--	1015	100	10.8	--	--	6.8	56	108	--	[illegible]	0.04	0.5	0.20	0.7	0.02

Table 5. Chemical Data

N. E. Cape Fear River at N. C. Highway 11 (near Kornegay Dam Site)

(Station CF-5)

Date	Sample Time	Temp. °C.	pH Units	Alk. $CaCO_3$ mg/l	Acidity $CaCO_3$ mg/l	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Vol. mg/l	Specific Cond. µmho/cm	Color Units	Lignin mg/l	B.O.D. 2-day mg/l	B.O.D. 5-day mg/l	D.O. mg/l	C.O.D. mg/l	Flow cfs	Gauge ht.	Org.N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot.Phos. mg/l (P)	Iron mg/l (Fe)	Manag. mg/l (Mn)
7-29-68	10:50 A	25	6.3	7	4	4	< 5	480	-	-	136	11.0	0.8	1.6	9.6	64	132	3.17	0.53	0.04	1.2	0.19	0.9	0.02
30	9:55 A	-	6.3	7	5	12	15	320		-	120	15.4	0.8	1.9	7.2	51	151.5	4.24	0.58	0.06	0.8	0.19	1.1	0.30 (1)
31	1:45 P	24	6.2	6	4	5	10	270	-	-	152	15.4	-	0.2	7.8	45	145	3.94	0.48	0.08	0.4	0.11	0.7	0.03
8- 1-68	12:15 P	24	6.5	7	4	4	< 5	350	-	-	132	12.6	-	0.2	7.8	54	134	3.35	0.37	0.06	1.2	0.16	1.0	0.03
2	7:00 A	24	6.6	9	4	4	< 5	380	-	-	132	11.2	0.2	-	7.4	51	132	3.22	0.42	0.05	1.0	0.19	1.0	0.02
5	11:00 A	26	6.6	-	-	5	-	445	40	830	104	12.4	-	-	7.2	43	130	2.94	0.45	0.04	1.4	0.21	0.8	0.02
6	12:15 P	26	6.7	-	-	5	-	-	-	840	124	11.8	-	-	7.9	52	129	2.88	0.50	0.06	0.6	0.24	0.9	0.03
7	12:30 P	27	6.6	-	-	4	-	-	-	1035	100	10.8	-	-	7.2	67	129	2.86	0.44	0.05	0.6	0.21	0.7	< 0.02
8	9:30 A	26	6.6	-	-	4	-	-	-	1025	104	9.8	-	-	7.7	65	129	2.82	0.43	0.05	0.6	0.21	0.8	< 0.02
9	7:30 A	25	6.6	-	-	4	-	-	-	995	100	10.4	-	-	7.1	62	126	2.79	0.53	0.05	0.8	0.24	0.8	0.02
Avg.		25	6.5	7	4	5	-	370	-	965	120	12.1	0.6	1.0	7.7	55	134	--	0.47	0.05	0.9	0.20	0.9	< 0.02
Max.		27	6.7	9	5	12	-	480	-	1035	152	15.4	-	-	9.6	67	152	--	0.58	0.08	1.4	0.24	1.1	.30
Min.		24	6.2	6	4	4	-	270	-	830	100	9.8	-	-	7.1	43	128	--	0.37	0.04	0.6	0.11	0.7	< 0.02

(1) Not used in average.

Table 6. Chemical Data

Contentnea Creek at Wilson Co. Road 1154 (station CC-6)

Date	Sample Time	Temp. °C.	pH Units	Alk. $CaCO_3$ mg/l	Acidity $CaCO_3$ mg/l	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Vol. mg/l	Specific Cond. umho/cm	Color Units	Lignin mg/l	B.O.D. 2-day mg/l	B.O.D. 5-day mg/l	D.O. mg/l	C.O.D. mg/l	Flow cfs	Gauge Ht.	Org.N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot.Phos. mg/l (P)	Iron mg/l (Fe)	Mang. mg/l (Mn)
7-29-68	12:55 P	25	6.7	16	5	12	< 5	110	-	-	152	6.2	0.1	0.2	7.1	27	55.5	2.18	0.47	0.07	0.4	0.11	2.5	0.07
30	1:00 P	-	6.8	18	4	12	10	65	-	-	140	8.8	0.1	0.7	6.5	21	54	2.15	0.41	0.07	0.4	0.15	2.3	0.08
31	10:30 A	24	6.8	13	4	12	< 5	80	-	-	132	7.4	0.3	0.2	5.8	23	54	2.15	0.38	0.06	0.4	0.11	2.4	< 0.02
8- 1-68	9:50 A	24	6.9	18	3	10	< 5	65	-	-	116	6.0	-	0.3	6.0	21	52.5	2.10	0.39	0.06	0.4	0.12	2.4	0.08
2	10:00 A	26	6.9	18	4	10	< 5	95	-	-	148	5.4	0.2	-	5.7	18	52	2.08	0.33	0.05	0.4	0.11	2.2	0.06
5	2:10 P	28	6.8	-	-	8	-	60	30	70	124	7.0	-	-	5.7	14	52	2.08	0.33	0.05	0.4	0.11	2.0	0.08
6	9:50 A	26	6.9	-	-	8	-	-	-	75	104	5.8	-	-	6.0	20	50.5	2.04	0.26	0.06	0.2	0.11	2.2	0.06
7	10:00 A	28	6.9	-	-	8	-	-	-	75	108	5.8	-	-	6.1	15	50.5	2.04	0.30	0.06	0.2	0.11	2.0	0.08
8	12:00 N	28	6.9	-	-	8	-	-	-	70	120	4.4	-	-	6.1	29	48.5	1.98	0.35	0.05	0.2	0.10	1.8	0.04
9	10:10 A	28	6.8	-	-	8	-	-	-	65	108	4.2	-	-	6.0	10	47.5	1.96	0.34	0.05	0.2	0.11	2.0	0.06
Avg.		26	6.8	17	4	10	-	80	-	70	125	6.1	0.2	0.4	6.1	20	52	--	0.36	0.06	0.3	0.11	2.2	< 0.06
Max.		28	6.9	18	5	12	-	110	-	75	152	8.8	-	-	7.1	29	56	--	0.47	0.07	0.4	0.15	2.5	0.08
Min.		24	6.7	13	3	8	-	60	-	65	104	4.2	-	-	5.7	10	48	--	0.26	0.05	0.2	0.10	1.8	< 0.02

Table 7. Chemical Data

Contentnea Creek at Wilson Co. Road 1162 (Station CC-7)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Voletile mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2-day	BOD 5-day	D.O. mg/l	COD mg/l	Flow cfs	Gauge Ht.	Org. N mg/l	NH_3-N mg/l	NO_2-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29,1968	1:10P	26	6.9	15	4	13	< 5	110	-	-	124	8.0	--	--	7.2	30	54	2.17	0.43	0.04	0.4	0.11	2.6	0.07
30	1:35P	--	6.9	17	4	13	5	60	-	-	124	9.2	--	--	6.8	24	52	2.08	0.43	0.04	0.3	0.11	2.0	0.05
31	10:10A	24	6.8	16	2	12	10	80	-	-	120	8.0	--	--	6.8	20	51.5	2.06	0.38	0.01	0.4	0.11	2.4	< 0.02
Aug. 1	9:35A	24	6.8	18	4	12	5	65	-	-	124	6.4	--	--	6.6	22	50.3	2.00	0.40	0.04	0.5	0.14	2.3	0.08
2	10:20A	26	7.0	18	4	11	5	90	-	-	104	7.0	--	--	6.2	19	49.1	1.94	0.36	0.05	0.4	0.13	2.4	0.07
5	2:30P	28	6.8	-	-	12	-	65	25	65	104	7.6	--	--	6.0	17	47.8	1.87	0.47	0.04	0.5	0.12	2.0	0.08
6	9:30A	24	6.9	-	-	10	-	-	-	70	100	5.2	--	--	6.5	10	47.5	1.84	0.26	0.07	0.2	0.11	2.2	0.08
7	9:30A	28	6.9	-	-	10	-	-	-	75	100	6.8	--	--	6.8	10	46.7	1.80	0.50	0.10	0.1	0.12	2.0	0.09
8	12:00P	28	7.0	-	-	8	-	-	-	75	116	4.8	--	--	6.2	23	46.0	1.75	0.28	0.05	0.2	0.10	1.9	0.06
9	10:30A	27	6.9	-	-	8	-	-	-	70	120	4.4	--	--	6.2	6	45	1.70	0.36	0.06	0.2	0.10	1.9	0.09
Avg.		26	6.9	17	4	11	-	80	-	70	114	6.7	--	--	6.5	23	49	--	0.39	0.05	0.3	0.12	2.2	< 0.07
Max.		28	7.0	18	4	13	-	110	-	75	124	9.2	--	--	7.2	60	54	--	0.50	0.10	0.5	0.14	2.6	0.09
Min.		24	6.8	15	2	8	-	60	-	65	100	4.4	--	--	6.0	6	45	--	0.26	0.01	0.1	0.10	1.9	< 0.02

Table 8. Chemical Data

Wiggins Mill Pond Surface Outlet

(Station SC-8)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Vol. mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2-day mg/l	BOD 5-day mg/l	D.O. mg/l above	D.O. mg/l below	Wilson Pump cfs	Flow Over Dam cfs	Flow Total cfs	Gage Ht.	Org. N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)	COD mg/l
July 29,1966	12:20P	28	6.7	14	4	12	16	110	--	--	120	10.0	1.3	2.7	6.5	8.4	3.6	21	24.6	0.82	0.69	0.02	< 0.1	0.12	2.2	0.07	37
30	12:30P	--	6.8	15	3	15	19	70	--	--	144	12.2	1.9	4.4	6.9	4.8	4.3	13	17.3	0.78	0.79	0.05	< 0.1	0.16	2.0	0.10	36
31	11:00A	26	6.7	14	3	12	16	75	--	--	136	10.4	1.9	2.9	8.6	5.0	3.0	5	8.8	0.74	0.63	0.03	< 0.1	0.09	2.1	0.08	33
Aug. 1	10:25A	27	6.8	10	3	12	15	65	--	--	140	9.0	0.8	1.8	8.2	4.1	4.3	5	9.3	0.74	0.70	0.05	< 0.1	0.11	--	--	31
2	9:20A	27	6.8	15	4	16	16	85	--	--	152	9.4	0.8	0.8	6.2	3.4	4.7[1]	3	7.7	0.72	0.58	0.04	< 0.1	0.08	2.0	0.10	32
3	1:30P	31	7.0	--	-	8	--	65	35	60	116	11.2	--	--	7.0	6.5	4.6[1]	3	7.6	0.72	0.66	0.07	< 0.1	0.09	2.0	0.10	19
6	10:20A	30	7.0	--	-	6	--	--	--	65	128	7.4	--	--	7.0	5.2	4.7[1]	3	7.7	0.72	0.71	0.07	< 0.1	0.10	1.9	0.08	32
7	10:30A	30	7.1	--	-	7	--	--	--	70	120	9.4	--	--	9.0	5.0	9.6[1]	3	12.6	0.72	0.73	0.08	< 0.1	0.09	1.7	0.08	35
8	11:35A	31	7.4	--	-	7	--	--	--	65	124	8.2	--	--	8.3	6.4	9.0[1,2]	2	11.0	0.71	0.67	0.06	< 0.1	0.08	1.8	0.07	37
9	12:45A	30	7.1	--	-	6	--	--	--	60	136	7.8	--	--	8.1	4.5	9.0[1,2]	3	12.0	0.72	0.74	0.05	< 0.1	0.10	1.8	0.09	26
Avg.		29	6.9	14	3	10	16	80	--	63	132	9.9	1.5	2.9	7.7	5.4	-		10.1[2]	--	0.69	0.05	-	0.10	1.9	0.08	32
Max.		31	7.4	15	4	15	19	110	--	70	152	12.2	--	--	9.0	8.4	-		24.6[2]	--	0.79	0.08	-	0.16	2.2	0.10	38
Min.		26	6.7	10	3	6	16	65	--	60	116	7.4	--	--	6.5	3.4	-		7.6[2]	--	0.58	0.02	-	0.08	1.7	0.07	19

[1] Lake level lowered below crest of dam by pumping. Stream flow downstream due to leakage through dam.

[2] Estimated

Table 9. Chemical Data

Toisnot Creek at N. C. Highway 58 near Silver Lake

(Station T-1)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. sus. Solids mg/l	Solids Total mg/l	Solids Volatile mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2-day mg/l	BOD 5-day mg/l	D.O. mg/l	COD mg/l	Flow cfs	Gauge Ht.	Org. N mg/l	NH_3-N mg/l	NO_2-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29	1:35P	29	6.5	8	6	7	10	65	--	--	140	12.8	--	--	7.0	36	17.5	1.20	0.81	0.06	< 0.1	0.06	1.6	0.08
30	1:50P	--	6.4	10	8	7	15	60	--	--	152	14.4	--	--	6.1	33	17.5	1.20	0.60	0.08	0.1	0.06	1.6	0.09
31	8:30A	27	6.3	8	5	7	15	110	--	--	152	12.2	--	--	7.5	35	16.6	1.17	0.76	0.08	< 0.1	0.08	1.6	0.09
Aug. 1	8:10A	28	6.3	7	6	7	10	60	--	--	124	11.8	--	--	7.3	35	17.0	1.1	0.71	0.11	< 0.1	0.06	--	--
2	10:45A	27	6.4	7	5	6	50	69	--	--	152	11.8	--	--	5.8	41	15.6	1.14	0.63	0.09	0.2	0.08	1.6	0.10
3	2:45P	29	6.5	"	"	6	--	90	15	50	124	12.6	--	--	6.4	14	15.6	1.14	0.60	0.08	0.1	0.05	1.3	0.12
6	8:00A	26	6.4	"	"	7	--	"	--	55	100	9.4	--	--	6.0	31	15.6	1.14	0.63	0.09	< 0.1	0.08	1.7	0.13
7	8:00A	27	6.5	"	"	7	--	"	--	55	96	10.6	--	--	6.0	27	15.6	1.14	0.58	0.06	< 0.1	0.05	1.2	0.14
8	12:45P	29	6.5	"	"	6	--	"	--	50	100	9.2	--	--	6.1	34	15.5	1.13	0.66	0.10	< 0.1	0.10	1.6	0.20
9	10:50A	28	6.4	"	"	5	--	"	--	55	104	10.2	--	--	5.7	22	15.6	1.14	0.60	0.07	< 0.1	0.06	1.4	0.14
Avg.		27	6.4	7	6	6	18	77	--	53	120	11.3	--	--	6.4	31	16.2	--	0.60	0.08	-	0.07	1.5	0.13
Max.		29	6.5	10	8	7	50	110	--	55	152	14.4	--	--	7.5	41	17.5	--	0.86	0.11	-	0.10	1.7	0.20
Min.		26	6.3	7	5	5	10	60	--	50	96	9.2	--	--	5.7	14	15.5	--	0.58	0.06	-	0.05	1.2	0.08

Table 10. Chemical Data

Lake Wilson Surface Outlet (Station T-16)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity units	Tot. Susp. Solids mg/l	Solids Total mg/l	Solids Vol. mg/l	Specific cond. µmho/cm	Color units	Lignin mg/l	BOD 2-day mg/l	BOD 5-day mg/l	D.O. mg/l above	D.O. mg/l below	COD mg/l	Flow cfs	Gauge Ht.	Org. N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29,1970	2:05P	30	6.4	6	4	8	10	90	--	--	160	14.2	--	--	7.6	8.7	42	14.5	0.58	0.83	0.04	< 0.1	0.07	1.6	0.08
30	2:12P	--	6.7	6	5	6	15	79	--	--	160	15.6	--	--	8.4	7.4	42	14.5	0.56	0.78	0.05	< 0.1	0.07	1.5	0.09
31	9:00A	27	6.4	6	4	6	15	93	--	--	140	13.4	--	--	6.8	7.7	41	14	0.56	0.76	0.04	< 0.1	0.05	1.6	0.09
Aug. 1	8:40A	27	6.5	8	4	6	10	69	--	--	160	15.2	--	--	8.0	7.1	40	13.8	0.55	0.63	0.07	< 0.1	0.06	1.5	0.06
2	11:00A	28	6.5	9	5	8	40	85	--	--	185	13.4	--	--	6.5	7.2	49	13.2	0.52	0.91	0.08	< 0.1	0.07	1.6	0.08
5	3:15P	35	6.9	-	-	6	--	60	60	90	140	14.4	--	--	8.2	7.0	80	12.4	0.48	0.85	0.05	< 0.1	0.05	1.4	0.10
6	9:30A	30	6.7	-	-	8	--	--	--	90	144	11.4	--	--	7.9	7.3	55	12.4	0.46	0.72	0.05	< 0.1	0.05	1.4	0.08
7	8:30A	31	6.6	-	-	7	--	--	--	90	144	12.2	--	--	7.8	6.6	58	12.4	0.48	0.70	0.05	< 0.1	0.05	1.4	0.08
8	1:20P	32	6.8	-	-	6	--	--	--	90	132	11.4	--	--	8.0	7.4	54	11.8	0.46	0.69	0.06	< 0.1	0.05	1.2	0.06
9	11:15A	31	6.6	-	-	7	--	--	--	90	156	11.2	--	--	7.4	6.9	54	12.0	0.47	0.84	0.06	< 0.1	0.06	1.4	0.07
Avg.		30	-				6	6	--	90	150	13.1	--	--	7.8	7.3	53	13.1	--	0.77	0.0	-	0.06	1.5	0.09
Max.		35	-				6	-	--	90	160	16.6	--	--	-	8.7	80	14.5	--	1	0.09	-	0.07	1.6	0.10
Min.		27	-		3		10	60	--	90	140	11.2	--	--	6.8	6.6	40	11.8	--	0.63	0.04	-	0.05	1.2	0.06

Table 11. Chemical Data

Tolenot Creek at Wilson Co. Road 1527

(Station T-11)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Volatile mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2 day mg/l	BOD 5 day mg/l	D.O. mg/l	COD mg/l	Org. N mg/l	NH_3-N mg/l	NO_3-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)
July 29,1978	2:15P	29	6.4	7	4	8	10	85	-	-	140	13.4	--	--	8.0	41	0.88	0.10	0.2	0.07	1.5	0.05
30	2:40P	--	6.8	6	3	10	20	70	-	-	140	14.4	--	--	8.6	37	0.75	0.03	< 0.1	0.09	1.5	0.04
31	8:35A	24	6.5	8	3	12	15	95	-	-	172	14.2	--	--	7.0	39	0.85	0.11	0.1	0.09	1.7	0.08
Aug. 1	8:20A	27	6.5	8	3	10	30	60	-	-	168	14.4	--	--	8.6	38	0.79	0.10	< 0.1	0.07	1.6	0.04
2	11:20A	29	6.6	8	4	8	15	55	-	-	144	13.4	--	--	7.7	40	0.88	0.04	< 0.1	0.07	1.4	0.05
5	3:30P	31	6.4	-	-	10	-	65	35	50	144	12.8	--	--	8.1	54	0.79	0.05	< 0.1	0.07	1.4	0.06
6	8:00A	28	6.7	-	-	11	-	-	-	55	152	13.8	--	--	7.2	35	0.79	0.10	< 0.1	0.08	1.6	0.07
7	8:00A	29	6.6	-	-	10	-	-	-	50	124	13.4	--	--	7.8	43	0.73	0.06	< 0.1	0.08	1.4	0.07
8	1:30P	32	6.7	-	-	12	-	-	-	50	172	12.8	--	--	7.6	42	0.76	0.08	< 0.1	0.08	1.7	0.08
9	11:30A	31	6.8	-	-	10	-	-	-	50	144	12.2	--	--	7.8	34	0.77	0.04	< 0.1	0.08	1.4	0.06
Avg.		29	6.6	8	3	10	15	70	-	50	152	13.4	--	--	7.9	40	0.76	0.07	-	0.08	1.6	0.06
Max.		32	6.8	8	4	12	30	95	-	55	172	14.4	--	--	8.6	54	0.85	0.11	-	0.09	1.7	0.08
Min.		26	6.4	7	3	8	10	55	-	50	124	12.2	--	--	7.0	34	0.66	0.03	-	0.06	1.4	0.05

Table 12. Chemical Data

Tolsnot Creek immediately downstream from Lake Tolsnot

(Station T-12)

Date	Sample Time	Temp °C	pH Units	Alk. mg/l $CaCO_3$	Acidity mg/l $CaCO_3$	Turbidity Units	Tot. Sus. Solids mg/l	Solids Total mg/l	Solids Vol. mg/l	Specific cond. µmho/cm	Color Units	Lignin mg/l	BOD 2-day mg/l	BOD 5-day mg/l	D.O. mg/l above	D.O. mg/l below	Wilson Pump cfs	Flow, cfs Stream	Flow, cfs Total	Gauge Ht.	Org. N mg/l	NH_3-N mg/l	NO_2-N mg/l	Tot. Phos. mg/l (P)	Iron mg/l (Fe)	Manganese mg/l (Mn)	COD
July 29,1960	2:40P	29	6.6	7	4	9	15	90	--	--	168	14.4	--	--	9.0	8.2	5.4	14.7	25.1	1.64	0.91	0.04	< 0.1	0.06	1.8	0.07	43
30	3:00P	--	6.7	9	3	10	15	70	--	--	176	14.4	--	--	8.4	8.0	5.4	--	--	-	0.75	0.03	< 0.1	0.06	1.6	0.08	44
31	8:20A	27	6.6	8	2	9	15	110	--	--	152	14.4	--	--	8.4	8.4	5.2	21.0	26.2	1.72	0.85	0.04	< 0.1	0.09	1.4	0.07	44
Aug. 1	8:00A	26	6.4	9	5	14	20	80	--	--	172	15.2	--	--	5.0	7.3	6.0	18.1	24.1	1.52	0.81	0.12	< 0.1	0.09	2.0	0.12	39
2	11:35A	29	6.6	8	3	13	45	60	--	--	180	14.4	--	--	8.1	7.8	4.9	19.5	24.4	1.62	0.89	0.05	< 0.1	0.09	1.8	0.07	53
5	4:00P	32	7.2	-	-	10	--	60	60	90	152	11.6	--	--	7.1	8.0	5.2	17.5	22.7	1.46	0.81	0.05	< 0.1	0.06	1.4	0.08	49
6	7:45A	28	6.7	-	-	9	--	--	--	90	120	12.6	--	--	7.4	7.5	5.7	19.0	24.7	1.59	0.86	0.09	< 0.1	0.07	1.7	0.08	0
7	7:45A	30	6.6	-	-	11	--	--	--	55	164	13.4	--	--	7.4	7.4	7.0	17.0	24.0	1.44	0.95	0.14	< 0.1	0.09	1.6	0.07	39
8	1:45P	34	6.9	-	--	10	--	--	--	90	164	13.0	--	--	8.4	7.2	5.0[1]	18.8	23.8	1.58	0.81	0.06	< 0.1	0.07	1.6	0.07	41
9	12:00N	31	6.8	-	--	10	--	--	--	90	160	12.6	--	--	7.9	7.2	5.0[1]	17.5	22.5	1.48	0.85	0.04	< 0.1	0.06	1.7	0.07	35
Avg.		30	6.7	8	3	10	20	80	--	90	161	13.6	--	--	7.7	7.7	-	-	24.2	-	0.85	0.07	-	0.07	1.7	0.09	43
Max.		34	7.2	9	5	14	45	110	--	55	180	15.2	--	--	9.0	8.4	-	-	25.1	-	0.95	0.14	-	0.09	2.0	0.12	53
Min.		26	6.4	7	2	9	15	60	--	90	120	11.6	--	--	5.0	7.2	-	-	22.5	-	0.75	0.03	-	0.06	1.4	0.07	0

[1] estimated

[2] not used in average

Table 13. Chemical Data, surface vs. bottom

(Milligrams per liter)

Lake	Depth	Date	Lignin	Org.-N	NO_3-N	NH_3-N	Total N	Total Phosphorus (P)	Iron	Manganese
Wiggins Mill Pond	Surface	8-1-68	11.4	0.71	< 0.1	0.06	0.77	0.10	2.1	0.10
		8-5-68	9.6	0.54	< 0.1	0.05	0.59	0.09	1.8	0.09
		Average	10.5	0.62	< 0.1	0.06	0.68	0.10	2.0	0.10
	Bottom (13 ft.)	8-1-68	24.4	0.91	0.1	0.25	1.26	0.30	12.5	0.85
		8-5-68	14.8	0.58	0.1	0.13	0.81	0.16	8.0	0.85
		Average	19.6	0.74	0.1	0.19	1.03	0.23	10.2	0.85
Lake Wilson	Surface	8-6-68	14.4	0.82	< 0.1	0.03	0.85	0.07	1.4	0.08
		8-7-68	11.8	1.10	< 0.1	0.03	1.13	0.07	1.9	0.06
		Average	13.1	0.96	< 0.1	0.03	0.99	0.07	1.6	0.07
	Bottom (9 ft.)	8-6-68	17.4	0.77	< 0.1	0.10	0.87	0.07	3.4	0.28
		8-7-68	16.4	1.00	< 0.1	0.05	1.05	0.10	4.2	0.16
		Average	16.9	0.88	< 0.1	0.08	0.96	0.08	3.8	0.22

Phytoplankton

Average Standing Crop

29 July - 10 August, 1968

Table 14

	Contentnea Creek		Toisnot Creek	
	No./ml	Volume(ppm)	No./ml	Volume(ppm)
Greens	630	0.35	1,844	1.68
Bluegreens	100	0.02	730	0.07
Diatoms	32	0.08	3,314	1.10
Other	trace	--	46	0.20
Total	762	0.45	5,934	3.05

	Wiggins Mill Pond		Lake Wilson	
	No./ml	Volume(ppm)	No./ml	Volume(ppm)
Greens	6,549	2.87	6,550	1.94
Bluegreens	79	0.02	229	0.13
Diatoms	472	1.02	10,622	4.24
Other	157	0.82	771	2.69
Total	7,257	4.73	18,172	8.90

	Northeast Cape Fear River	
	No./ml	Volume(ppm)
Greens	746	0.04
Bluegreens	trace	--
Diatoms	35	0.77
Other	trace	--
Total	781	0.81

Periphyton

Standing Crop

Exposure Period - 26 July - 7 August 1968

Table 15

Lake	Depth (ft.)	Greens	Bluegreens	Diatoms	Other	Total	Chlorophyll a ($\mu g/in^2$)
		(numbers/in^2)					
Wilson	1	27,825	2,550	80,050	850	111,275	1.37
"	2	33,365	4,634	139,020	927	177,946	1.27
"	3	23,021	10,624	108,903	4,427	146,975	2.84
"	4	11,816	844	53,172	1,688	67,520	1.36
"	5	10,010	--	18,352	--	28,362	1.68
"	6	2,227	--	8,017	--	10,244	0.48
"	7	--	--	3,531	--	3,531	--
"	8	429	--	2,146	--	2,575	--
Wiggins	1	48,686	6,310	54,988	1,803	111,787	0.53
"	2	35,993	11,998	27,994	2,000	77,985	0.77
"	3	67,303	312,868	12,733	--	392,904	0.56
"	4	12,159	255,339	12,159	3,474	283,131	0.28
"	5	7,224	5,418	2,709	2,709	18,060	--
"	6	884	2,210	442	--	3,536	--
"	7	--	341	--	--	341	--

Benthic Invertebrates

Numbers/ft^2

1 August 1968

Table 16

Lake	Wilson	Wilson	Wilson	Wilson	Wilson	Wilson	Wilson	Wiggins	Wiggins	Wiggins	Wiggins	Wiggins
Station	C	E	G	F	H	D	A	4-A	6-A	2-A	3-A	5-A
Depth(ft)	1	2	3	3	5	6.5	8	4	4	7	8	11
Clam	4		8									
Leech	12											
Snail			20									
Flatworm			4									
Scud			20									
Shrimp			8									
Mayfly		4										
Dragonfly		4										
Caddisfly			4									
Chironomid midge		96	96	4	84	4	16	24	8		8	28
Phantom midge				32	48	16	16	4	28	228	32	260
Sludgeworm	112	204		104	108	16	48	12	26	160	216	28
Total/ft^2	128	308	160	140	240	36	80	40	64	388	256	292

TABLE 17. Chemical Constituents in Waters Used in Leaching Studies

(milligrams per liter)

Day	NO_3-N	NH_3-N	Total Inorganic N	Organic N	Total N	Total Phosphorus (P)	Iron	Manganese	Lignin
				Aerobic Clear* Water 9AO*					
0	< 0.1	0.04	0.04	0.28	0.32	0.02	< 0.2	0.10	1.2
2	< 0.1	0.06	0.06	0.27	0.33	0.02	< 0.2	0.05	3.8
5	< 0.1	0.05	0.05	0.17	0.22	0.01	00	< 0.02	1.2
10	< 0.1	0.07	0.07	0.26	0.33	0.01	0.2	00	0.2
				Aerobic Dark* Water 1° AO					
0	1.2	0.25	1.45	0.55	2.0	0.22	1.1	0.04	12.8
2	0.6	0.23	0.83	0.57	1.40	0.26	1.2	0.02	13.0
5	0.2	0.11	0.21	0.38	0.59	0.18	0.8	< 0.02	11.6
10	1.4	0.11	1.51	0.45	1.96	0.19	0.8	00	10.2
				Anaerobic Clear Water 9NO					
0	< 0.1	0.03	0.03	0.23	0.26	0.03	< 0.2	0.10	1.6
2	< 0.1	0.05	0.05	0.19	0.24	0.02	< 0.2	0.07	1.6
5	< 0.1	0.06	0.06	0.18	0.24	0.01	< 0.2	0.04	0.6
10	< 0.1	0.07	0.07	0.16	0.23	0.02	< 0.2	0.03	00
				Anaerobic Dark Water 10NO					
0	1.3	0.30	1.6	0.70	2.30	0.25	1.3	0.03	13.8
2	0.9	0.33	1.23	0.44	1.63	0.24	1.0	0.03	12.8
5	0.9	0.41	1.31	0.62	1.93	0.20	1.0	0.05	11.4
10	0.9	0.43	1.33	0.47	1.80	0.19	0.8	0.03	11.2

*see text

TABLE 18. Chemical Constituents in Waters

Leaching Leaf Litter*

(milligrams per liter)

Day	NO_3-N	NH_3-N	Total Inorganic N	Organic N	Total N	Total Phosphorus (P)	Iron	Manganese	Lignin
				Aerobic Clear* Water 1AL*					
0	< 0.1	0.04	0.04	0.28	0.32	0.02	< 0.2	0.10	1.2
2	< 0.1	0.21	0.21	0.82	1.03	0.17	0.8	0.03	12.8
5	< 0.1	0.28	0.28	0.81	1.09	0.25	0.7	0.02	16.0
10	0.1	0.19	0.20	0.76	0.96	0.48	1.4	< 0.02	20.8
				Aerobic Dark* Water 2AL					
0	1.2	0.25	1.45	0.55	2.0	0.22	1.1	0.04	12.8
2	1.4	0.37	1.77	0.73	2.50	0.26	1.0	0.10	14.4
5	0.2	0.60	0.80	0.60	1.40	0.20	0.9	0.11	16.4
10	0.3	0.53	0.83	0.82	1.65	0.41	2.0	0.12	23.4
				Anaerobic Clear Water 1NL					
0	< 0.1	0.03	0.03	0.23	0.26	0.03	< 0.2	0.10	1.6
2	< 0.1	0.51	0.51	1.2	1.72	0.33	1.0	0.06	15.6
5	< 0.1	0.84	0.84	0.85	1.69	0.40	1.3	0.07	16.2
10	< 0.1	1.00	1.00	0.98	1.98	0.66	2.6	0.10	28.8
				Anaerobic Dark Water 2NL					
0	1.3	0.30	1.6	0.70	2.30	0.25	1.3	0.03	13.8
2	1.0	0.61	1.61	0.78	2.39	0.30	1.6	0.20	17.0
5	0.5	0.78	1.28	0.59	1.87	0.31	1.8	0.21	18.0
10	< 0.1	1.00	1.00	0.87	1.87	0.66	4.4	0.24	26.6

*See text

TABLE 19. Chemical Constituents in Waters

Leaching Muck*

(milligrams per liter)

Day	NO_3-N	NH_3-N	Total Inorganic N	Organic N	Total N	Total Phosphorus (P)	Iron	Manganese	Lignin
				Aerobic Clear* Water 7AM*					
0	< 0.1	0.04	0.04	0.28	0.32	0.02	< 0.2	0.10	1.2
2	0.1	0.04	0.14	0.82	0.96	0.15	0.9	0.05	9.0
5	0.1	0.06	0.16	0.73	0.89	0.12	1.0	0.02	6.6
10	0.3	0.05	0.35	0.82	1.17	0.17	1.4	0.00	9.0
				Aerobic Dark* Water 8AM					
0	1.2	0.25	1.45	0.55	2.0	0.22	1.1	0.04	12.8
2	0.8	0.19	0.99	0.60	1.59	0.24	1.0	0.04	12.0
5	0.3	0.07	0.37	0.40	0.77	0.13	0.6	0.04	8.6
10	1.3	0.05	1.35	0.38	1.73	0.11	0.6	0.05	7.6
				Anaerobic Clear Water 7NM					
0	< 0.1	0.03	0.03	0.23	0.26	0.03	< 0.2	0.10	1.6
2	0.2	0.15	0.35	1.6	1.95	0.46	5.5	0.07	6.4
5	< 0.1	0.16	0.16	0.82	0.96	0.24	1.0	0.05	12.2
10	< 0.1	0.25	0.25	0.85	1.10	0.34	1.6	0.04	7.8
				Anaerobic Dark Water 8NM					
0	1.3	0.30	1.6	0.70	2.30	0.25	1.3	0.03	13.8
2	1.3	0.32	1.62	0.44	2.06	0.22	1.2	0.04	12.4
5	1.4	0.39	1.79	0.43	2.22	0.16	0.6	0.04	10.6
10	0.8	0.42	1.32	0.35	1.67	0.13	1.2	0.06	8.6

*See text

TABLE 20. Chemical Constituents in Waters Leaching Loam *

(milligrams per liter)

Day	NO_3-N	NH_3-N	Total Inorganic N	Organic N	Total N	Total Phosphorus (P)	Iron	Manganese	Lignin
				Aerobic Clear* Water 5AD*					
0	< 0.1	0.04	0.04	0.28	0.32	0.02	< 0.2	0.10	1.2
2	< 0.1	0.03	0.03	0.49	0.52	0.10	0.7	0.03	5.4
5	0.1	0.02	0.12	0.38	0.50	0.04	0.4	0.02	1.6
10	0.2	0.04	0.24	0.41	0.65	0.10	0.4	00	2.6
				Aerobic Dark* Water 6AD					
0	1.2	0.25	1.45	0.55	2.0	0.22	1.1	0.04	12.8
2	1.4	0.18	1.58	0.48	2.06	0.21	1.0	0.02	12.6
5	1.7	0.07	1.77	0.45	2.22	0.12	0.6	0.06	9.0
10	1.7	0.02	1.72	0.38	2.10	0.10	0.6	0.04	8.0
				Anaerobic Clear Water 5ND					
0	< 0.1	0.03	0.03	0.23	0.26	0.03	< 0.2	0.10	1.6
2	< 0.1	0.11	0.11	0.62	0.73	0.16	1.0	0.04	8.6
5	< 0.1	0.16	0.16	0.54	0.70	0.13	0.9	0.04	5.0
10	< 0.1	0.26	0.26	0.49	0.75	0.10	1.1	0.05	4.6
				Anaerobic Dark Water 6ND					
0	1.3	0.30	1.6	0.70	2.30	0.25	1.3	0.03	13.8
2	1.3	0.33	1.63	0.48	2.11	0.21	1.4	0.03	13.4
5	1.0	0.41	1.41	0.42	1.83	0.16	1.3	0.04	11.8
10	0.5	0.45	0.95	0.40	1.35	0.11	1.0	0.05	8.8

*See text

TABLE 21. Chemical Constituents in Waters Leaching Sand*

(milligrams per liter)

Day	NO_3-N	NH_3-N	Total Inorganic N	Organic N	Total N	Total Phosphorus (P)	Iron	Manganese	Lignin
				Aerobic Clear* Water 3AS*					
0	< 0.1	0.04	0.04	0.28	0.32	0.02	< 0.2	0.10	1.2
2	< 0.1	0.05	0.05	0.28	0.33	0.03	< 0.2	0.03	1.6
5	0.1	0.04	0.14	0.24	0.38	0.03	< 0.2	< 0.02	0.0
10	0.2	0.03	0.23	0.28	0.51	0.06	00	00	1.0
				Aerobic Dark* Water 4AS					
0	1.2	0.25	1.45	0.55	2.0	0.22	1.1	0.04	12.8
2	0.8	0.16	0.96	0.56	1.52	0.22	1.0	< 0.02	12.4
5	0.5	0.14	0.64	0.55	1.19	0.21	0.6	< 0.02	10.2
10	1.7	0.07	1.77	0.50	2.27	0.17	0.6	00	10.8
				Anaerobic Clear Water 3NS					
0	< 0.1	0.03	0.03	0.23	0.26	0.03	< 0.2	0.10	1.6
2	< 0.1	0.11	0.11	0.25	0.36	0.07	0.2	0.06	1.4
5	< 0.1	0.24	0.24	0.40	0.64	0.09	0.3	0.05	1.0
10	< 0.1	0.31	0.31	0.27	0.58	0.13	0.2	0.04	2.4
				Anaerobic Dark Water 4NS					
0	1.3	0.30	1.6	0.70	2.30	0.25	1.3	0.03	13.8
2	1.3	0.31	1.61	0.55	2.16	0.22	1.0	0.04	11.6
5	1.2	0.28	1.48	0.38	1.86	0.20	0.8	0.03	10.2
10	1.6	0.13	1.73	0.43	2.16	0.20	0.8	0.05	9.6

*See text

TABLE 22

WEATHER INFORMATION
WILSON 2 W STATION

Wilson, N. C.

Date 1968		Temp. °F. Max.	Min.	Mean	Rainfall in.
July	1	98	69	83.5	-
	2	96	71	83.5	-
	3	94	69	81.5	2.39
	4	71	67	69.0	0.19
	5	73	68	70.5	1.17
	6	86	67	76.5	0.01
	7	86	64	75.0	-
	8	85	62	73.5	-
	9	76	64	70.0	0.44
	10	82	69	75.5	0.02
	11	83	71	77.0	1.21
	12	85	71	78.0	0.14
	13	89	72	80.5	0.38
	14	90	72	81.0	0.03
	15	93	73	83.0	-
	16	92	70	81.0	T
	17	92	71	81.5	T
	18	91	69	80.0	0.05
	19	90	70	80.0	0.05
	20	88	67	77.5	T
	21	89	64	76.5	-
	22	91	67	79.0	-
	23	93	70	81.5	-
	24	92	71	81.5	-
	25	94	70	82.0	0.03
	26	90	74	82.0	0.23
	27	88	72	80.0	T
	28	92	73	82.5	-
	29	83	71	77.0	0.04
	30	87	69	78.0	-
	31	88	69	78.5	-
Avg. or Sum.		88.0	69.2	78.6	6.38
August	1	92	73	82.5	-
	2	93	72	82.5	-
	3	95	73	84.0	-
	4	94	73	83.5	0.10
	5	95	71	83.0	-
	6	97	72	84.5	-
	7	99	73	86.0	-
	8	96	74	85.0	-
	9	97	73	85.0	1.26
Avg. or Sum.		95.3	72.7	84.0	1.36
Avg. for Survey (7/29 - 8/9)		93.0	71.9	82.4	1.40

TABLE 23

BOTTOM OXYGEN UPTAKE RATES

July-August, 1968

Location	Temperature °C	Oxygen Uptake Rate gm. O_2/sq.m/day
Wiggins Mill Pond, N. C.		
Channel, 3,700 ft. from dam	27	1.27
Out of channel, 3,200 ft. from dam	27	1.50
Entrance of Contentnea Creek	25	0.70
Average		1.16
Lake Wilson, N. C.		
3,000 ft. from dam	27	0.94
2,000 ft. from dam	26	0.86
Average		0.90

TABLE 24

Waste Inventory, Mt. Olive, N. C.

Source	Est. Pop. Served	Avg. Daily Flow, MGD	Pop. Equiv. Discharged	Treatment	Receiving Stream
Mt. Olive	3,600	0.387	462	Secondary	N. E. Cape Fear River
Mt. Olive Pickle Co.	-	0.110	2,700	Secondary	Barlow Branch

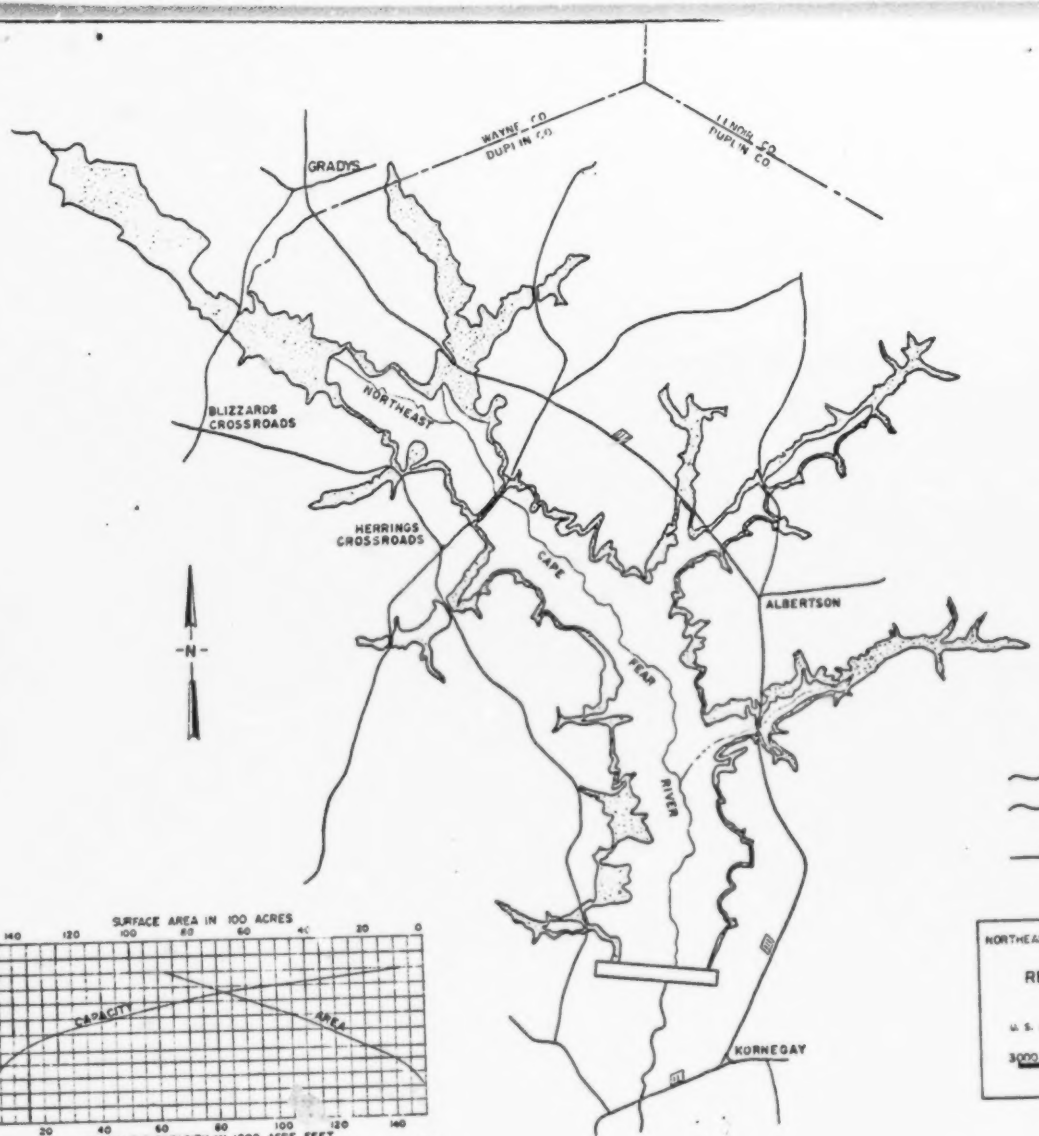
(1) Anon. 1967. Water Quality Control Study - Northeast Cape Fear River Basin - North Carolina. U. S. D. I., Fed. Water Pollution Control Admin., Charlottesville, Va.

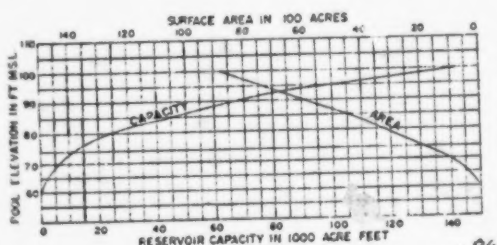
TABLE 25

CHEMICAL QUANTITIES OF GROUND WATER SUPPLIES[1]

Well No.	Well Location	Iron mg/l	Calcium mg/l	Total Hardness mg/l $CaCO_3$	pH Units	Total Dissolved Solids mg/l
2	Calypso	0.14	8.1	26	6.5	88
9	Faison	1.1	15	46	6.8	96
32	Warsaw	0.36	56	144	7.3	177
43	Kenansville	0.18	43	112	7.7	148
47	Beaulaville	0.35	35	115	7.9	164
57	Rose Hill	0.21	52	136	7.7	166
84	Wallace	0.55	74	218	7.3	272
21	Kornegay	0.16	30	88	7.7	122
	Avg.	0.38	39	110	7.4	154

(1) Le Grand, Harry E., "Geology and Ground-Water Resources of Wilmington-New Bern Area," Ground Water Bull. No. 1, North Carolina Department of Water Resources, Raleigh, N. Carolina, 1960.





AREA — CAPACITY CURVES

96

LEGEND

TOP OF FLOOD CONTROL POOL EL. 92.5

TOP OF CONSERVATION POOL EL. 86.0

STATE HIGHWAY

NORTHEAST (CAPE FEAR) RIVER BASIN, NORTH CAROLINA

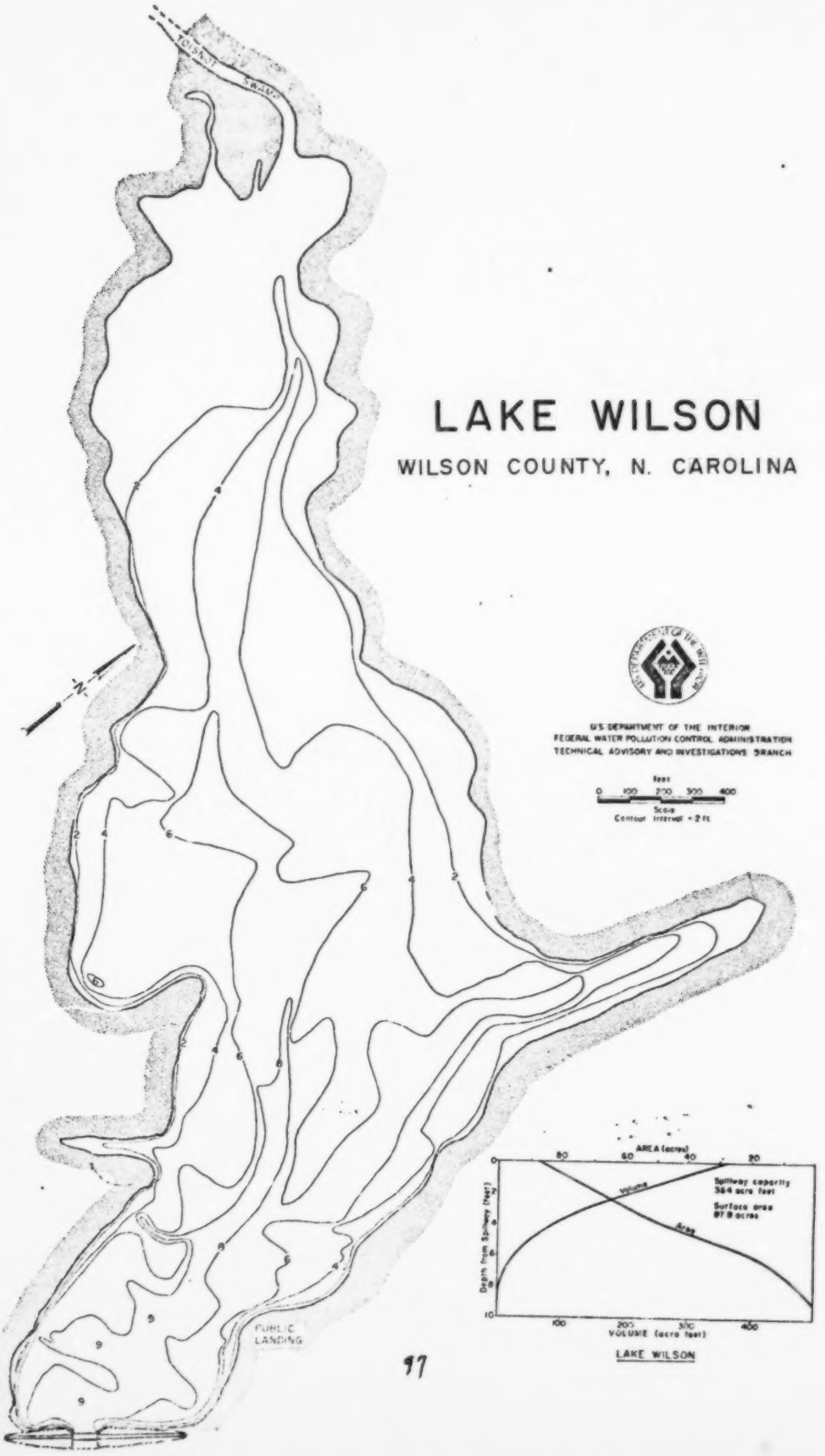
REDRAWN FROM

RESERVOIR MAP OF PROPOSED KORNEGAY PROJECT

U. S. ARMY ENGINEER DISTRICT, WILMINGTON N. C.

3000 0 3000 6000 9000

SCALE IN FEET


TOISNOT SWAMP
PUBLIC LANDING
LAKE WILSON
WILSON COUNTY, N. CAROLINA
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
TECHNICAL ADVISORY AND INVESTIGATIONS BRANCH
feet
0 100 200 300 400
Scale
Contour interval = 2 ft
AREA (acres)
80 60 40 20
Spillway capacity 364 acre feet
Surface area 87.8 acres
Volume
Area
Depth from Spillway (feet)
0 2 4 6 8 10
100 200 300 400
VOLUME (acre feet)
LAKE WILSON

WIGGINS MILL POND
WILSON COUNTY, N.C.